

PROCEEDINGS

of the American Academy of Forensic Sciences

**February 2007
Volume XIII**

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Research supported by ARC grant DP0557157 (Grant Support)
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7-Zip, ADSee, AIR, AIR DCFLDD, AIRDD, AnaDisk, Bulk Rename, Cain and Abel, CD-Creator, CD/DVD Diagnostic, Click View, Copernic, DataLifter, DBXtract, DCFLDD, DCFLDD Kernel, DD, DD Kernel, eFax Viewer, EnCase, ePreserver, ExMerge, EZPix, F-Prot, Filesee, FindDuplicates, FIRE, Forensic Toolkit (FTK), GHOST, Helix, IrFanView, Iside SHA, Karen's Cookie Viewer, Knoppix, LINEN, MD5 Hash, NERO, NetAnalysis, Norton System Works, Paraben, ParabenNEMX, PicoZip, Quick View Plus, RegDat, RegDATXP, Rifiuti, SafeBack, SamInside, SMART, SMART Arthur, SoloMaSSter, Thumbs Plus, VmWare, WindJView, WinHex, Yahoo Messenger Decoder (Discussion of Commercial Products or Services)
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- Allen S. Goldblatt, PhD - W1
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Fujifilm of North America, Tomar Co., R.C. Forensics, Universe Kogaku America (Discussion of Commercial Products or Services)
- Walter E. Goldstein, PhD, PE, MBA - B97
UNLV (Employee and Other Financial/Material Support)
Applied Biosystems (Discussion of Commercial Products or Services)
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Promega Corporation, Applied Biosystems, Inc., (Discussion of Commercial Products or Services)
Berkeley (Discussion of Unlabeled/Investigational Use of Product/Device)
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Zeiss (Discussion of Commercial Products or Services)
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Eli Lilly and Company, Pfizer, Carter-Reed, AstraZenica, Sanofi (Discussion of Commercial Products or Services) - G102
-
- ## H
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Discloses no financial relationships with commercial entities
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- Peter F. Hampl, DDS - F21
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Sionex, Smiths (Discussion of Commercial Products or Services)
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3M, Dentsply Caulk, GC America, Ivoclar Vivadent (Discussion of Commercial Products or Services)

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Wadsworth Center (Other financial/Material Support) **Disclosed for author by AAFS** – B143
Applied Biosystems, Inc., Integrated DNA Technologies, Roche Applied Science, NCBI (Discussion of Commercial Products or Services) - B143
Applied Biosystems, Inc., GENEART, Integrated DNA Technologies, Roche Applied Science (Discussion of Commercial Products or Services) – B144

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Biodesign, Molecular Probes, Novus Biologicals, Perkin Elmer Life Sciences (Discussion of Commercial Products or Services) – B146

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Hitachi (Discussion of Commercial Products or Services) – B94
Smith & Wesson (Discussion of Commercial Products or Services) **Disclosed for author by AAFS** – B94
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CMI, Inc. (Discussion of Commercial Products or Services)

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FORDISC (Discussion of Commercial Products or Services)

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Applied Biosystem, Inc., Beckman Coulter, Whatman (Discussion of
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Applied Biosystems, Inc., Microsoft Corporation (Discussion of
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AFDIL (Grant Support) – B175

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Applied Biosystems, Inc., Whatman (Discussion of Commercial Products or Services) – B155

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Exemplar vehicles (Discussion of Commercial Products or Services)

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Applied Biosystems, Inc., Roche Molecular Systems (Discussion of Commercial Products or Services) - B150

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Special Sessions



SS1 Ethics in the Forensic Sciences — When is the Line Crossed?

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After attending this presentation, attendees will gain a greater understanding of how a solid grounding in ethics, instilled early during forensic science education and training, can guide the scientist through many of the challenges they will encounter throughout their career.

This presentation will impact the forensic community and/or humanity by bringing the topic of ethics, which underlies everything forensic scientists do but is seldom discussed, to the forefront. Time will be included in the session for questions and answers between participants and attendees to foster an open (and hopefully continuing) discourse on the subject of ethics and what is considered ethical behavior.

“Tainted Science and Testimony Leads to Re-opening of 120 Cases over Last 15 years;” “Man Freed after Serving 21 years in Prison due to Lab ‘Oversight?’;” “State Crime Lab Employee Accused of Biased Analyses and Testimony” – all headlines that can confront, and scare, legitimately practicing forensic scientists. At the heart of this fear is wondering how such events occur since inherent in the practice of forensic science is the requirement for each practitioner to be ethical. The word “ethical” can be defined merely as proper conduct. Tacitly, a failure of forensic scientists to act ethically results in serious adverse outcomes. However, while seemingly simple to define, the application of being “ethical” is somewhat more obscure. That is, when is ethical, ethical, and when is it not?

Clearly, as part of an adversarial legal system, there must be room for differences of opinion in the forensic sciences. What is not clear, however, is when such differences are so divergent that individuals’ ethics are drawn into question. In this Interdisciplinary Symposium, a diverse pool of expertise has been compiled to address the role of ethics in the forensic sciences from several different perspectives with the intent of approaching an understanding when the proverbial ethical line is crossed.

The Symposium will start with a brief introduction to ethics, the role ethics plays in society and potential outcomes of unethical behavior, especially in the forensic sciences. How the AAFS has addressed ethics historically as well how accrediting agencies view ethics and the teaching of ethics within the forensic sciences will be covered. The media’s perspective of ethics, addressing both proper conduct by the media as well as its ability to uncover ethical issues in forensic science,

will be discussed by a nationally-recognized and award winning reporter on such issues. Lastly, various experts and disciplines within the forensic sciences where ethics or ethical issues are “ripe for the picking” will be represented.

As we move forward into the age of globalization, the forensic sciences worldwide will be under ever increasing scrutiny. In that respect, with the dissemination of information associated with the forensic sciences through such outlets as the internet, television and the print media, expectations and associated ethical issues will surface perhaps more than ever before. By meeting the issues of ethics in the forensic sciences head-on, we can hopefully be prepared for these challenges.

Ethics, Forensic Sciences, Expert

SS2 Young Forensic Scientists Forum Special Session "Forensic Science in an Age of Advancing Technology: Maintaining Scientific Integrity and Ethics"

Allison M. Curran, PhD, 18 Tyson Drive #204, Stafford, VA 22554; Marrah E. Lachowicz, MFS, GCCP, 1809 South Street, #101-166, Sacramento, CA 95814; Amanda K. Frohwein, BS, Drug Enforcement Administration, Special Testing and Research Laboratory, 13133 Park Crescent Circle, Herndon, VA 20171; Robin T. Bowen, MA, West Virginia University, 886 Chestnut Ridge Road, PO Box 6216, Morgantown, WV 26506-6216; Jennifer W. Mercer, BS, West Virginia University, 217 Clark Hall, Morgantown, WV 26506; James M. Adcock, PhD*, University of New Haven, 2445 Park Avenue, #46, Bridgeport, CT 06604; Scott D. Batterman, PhD*, 1964 Cardinal Lake Drive, Cherry Hill, NJ 08003; Jason H Byrd, Ph.D*, University of Florida, Department of Criminology, Law and Society, 201 Walkernhalle Road, PO Box 115950, Gainesville, FL 32611; Laurel Freas, BA*, CA Pound Human Identification Lab, University of Florida, PO Box 112545, Gainesville, FL 32611; Jeannette S. Fridie, BA*, 3060 Crescent Street, #3F, Astoria, NY 11102; Gregory L. Hill, JD*, National Clearinghouse for Science, Technology & the Law, 1401 61st Street South, Gulfport, FL 33707; Scott W. McMillion, PhD*, U.S. Department of Justice, FBI Omaha, Nebraska Branch, 10755 Burt Street, Omaha, NE 68114; Sini X. Panicker, MS*, Drug Enforcement Administration, Special Testing and Research Laboratory, 13550 Currey Lane, Chantilly, VA 20151; Heather A. Walsh-Haney, MA*, Forensic Science Initiative, Florida Gulf Coast University, Division of Justice Studies, College of Professional Studies, 10501 FGCU Boulevard South, Fort Myers, FL 33965-6565; and James G. Young, MD*, 4900 Yonge Street, Suite 240, Toronto, ON M2N 6A4, Canada*

After attending this presentation, attendees should be aware of advancing scientific and technological procedures in several fields of forensic science represented in the AAFS. In addition to this, session participants will have insight as to how each of these fields are maintaining integrity and ethics while working, teaching and practicing in forensics. While at the breakfast session, participants will also have a chance to learn about CV/resume building, internship opportunities and are encouraged to bring their own resume to be critiqued. While at the poster and slides sessions participants will be able to view posters and slide presentations by their peers.

This presentation will impact the forensic community and/or humanity by allowing session participants to learn about new scientific and

technical advances from established Academy members from various sections of the AAFS and incorporate this knowledge with the need to maintain scientific integrity and ethics as students, trainees, and professionals new to their respective fields.

Throughout the past nine years the Young Forensic Scientists Forum has provided a group of academy members ranging from students to professionals new to their career in forensics. The program has grown and changed drastically since its establishment in order to provide students, and scientists with five years experience or less, with the most quality information possible. The continuing goal is to provide this audience with topics relevant to their education, training, and skill levels. The program also seeks to provide a comfortable means for students and professionals new to their respective fields to contact and communicate with experienced members and fellows of the AAFS.

The session planned for the 59th AAFS meeting in San Antonio focuses on providing information regarding new scientific and technical advances in various fields of forensics—with our theme “Forensic Science in an Age of Advancing Technology: Maintaining Scientific Integrity and Ethics”. Speakers will provide insight into the respective fields; by sharing their expertise as well as the relevance of scientific integrity and ethics to forensic science in today’s society. The day session will be followed by an evening session titled “Young Forensic Scientists Forum, Poster Session.” The poster session will feature posters by undergraduate and graduate students as well as forensic science professions. The poster session will also present new, emerging forensic research and technologies to attendees. The poster session will allow young and emerging scientists to mingle with their peers, as well as established members of the academy in a comfortable setting.

The annual YFSF Breakfast Meeting will include a CV/resume review and tips on applying to forensic laboratory positions and how to advance in your field. Part of the breakfast meeting will focus on the importance of internships and volunteer positions in forensics. The annual YFSF Slides Session will include 8 presentations from students and emerging forensic scientists.

The session seeks to foster relationships between participants and their peers, as well as with established members of AAFS and provide for a smooth transition from student, to emerging scientist, to an established member. The forum setting and the variety of programs offered throughout the week not only provide academic and relevant technical information to our attendees, but also cultivate relationships that will last a career.

Young Forensic Scientists Forum, Ethics, Advancing Technology

ES1 The Role of the Forensic Scientist in Controversial, Politically Charged Death Investigations Internationally

Henry C. Lee, PhD, Forensic Laboratory, 278 Colony Street, Meriden, CT 06451; and Cyril H. Wecht, MD, JD*, 1119 Penn Avenue, Suite 400, Pittsburgh, PA 15222*

After attending this presentation, attendees will understand the important and highly sensitive role of forensic scientists in international death investigations. Utilization of universal knowledge and skills in resolving controversial matters and helping to achieve social justice.

Understandably, forensic scientists function completely in their respective countries, and only a small number ever have the opportunity to travel abroad in a formal professional capacity to attend international meetings, lecture, consult, and actually participate in forensic examinations. This presentation will impact the forensic community and/or humanity by making attendees more aware of how they can contribute to such investigations and play a role in important, complex matters that can have significant impact on international, political, diplomatic and even military decisions.

What do DNA testing, the O.J. Simpson murder trial, and “CSI” television programs have in common? All have contributed significantly to the ever increasing fascination and interest in the field of forensic science, not only in the United States, but throughout the world. Although the history of utilizing forensic scientific techniques and general concepts (simple and crude as they may have been in comparison to modern day practices) in the investigation of homicides and other criminal acts dates back thousands of years, it is doubtful that anyone would have predicted the phenomenal growth and development of this profession that we have witnessed in the past two decades.

Television shows, movies, and fictional novels that prominently feature forensic scientists as the major characters, with conspiracies and crimes that rely upon discovery and solution by forensic pathologists, toxicologists, psychiatrists, anthropologists, questioned document examiners and criminalists, have come to dominate their respective commercial categories. More importantly for societal purposes, insofar as both the civil and criminal legal arenas are concerned, contributions made by forensic scientists around the world have exceeded any other field of academic endeavor in achieving social justice. Whether it be the investigation of an individual murder or genocide; proving the sexual assault of one woman or the rape and pillage of an entire village; analysis of a single forged document or the Enron scandal; the determination of a single defendant’s sanity or the evaluation of the mindset and acts of a tyrannical dictator – more and more, forensic scientists are being called upon to methodically, objectively, and impartially provide answers for local, national, and international law enforcement agencies, judges, and other governmental entities, as well as for private citizens, corporations and various other groups.

Forensic science has no geographic boundaries. By its very nature, it is global in nature. Therein lies one of its greatest assets – it can be called upon at any time, applied, and utilized by trained, competent, and experienced experts in any country in the investigation and analysis of almost all criminal acts and many kinds of civil litigation.

The authors have participated in many such cases over the past three decades, individually and sometimes collaboratively, in Asia, Africa, the Mideast, Europe, Australia, the Caribbean, and Central America. Some of these investigations have been undertaken at the behest of private citizens, and more often, under the official aegis of a foreign government. A few of these challenging, complex, and highly controversial matters have been extremely important and significantly relevant with regard to national elections, government policies, and even international diplomatic relations.

The authors will discuss the roles they have played in these cases and expound upon the critical nature of forensic scientific evidence in helping to defuse and resolve highly sensitive and potentially explosive allegations that occasionally have global ramifications.

Forensic Science, Investigative, International



BS1 Medicine, Murder, and Mayhem in Ancient Greece

*Richard C. Froede, MD**, 3930 North Placita de la Escarpa, Tucson, AZ 85750; *Albert Leonard, Jr., PhD**, University of Arizona, PO Box 210067, Tucson, AZ 85721-0067; and *Richard D. Walter, MA**, 57 Lake Avenue, Montrose, PA 18801

After attending this presentation, participants will see that, historically, criminal activity and forensic application principles change very little.

During the time of Hippocrates, 460-380 B.C., the Mediterranean area sounds like an idyllic area to live in. Comparing that time to the present is like "Deja Vu all over again" (Y. Berra). The presenters will discuss certain aspects of history, medicine, and crime to show that things never change but will repeat endlessly throughout history. The presentation will demonstrate that today's problems existed centuries ago in age modified ways and today's principles could very easily be used then.

Historical Crime, Ancient Greece, Forensic Principle

BS2 Muhammad and Malvo: The Serial Sniper Case of October 2002

*Brendan F. Shea, MS**, and *Richard Guerrieri, MS, FBI Laboratory Division, 2501 Investigation Parkway, DNA Analysis Unit I, Quantico, VA 22135*

After attending this presentation, attendees will learn the sequence of events surrounding the sniper attacks in Washington, DC and the surrounding area, some of the contacts that took place between the perpetrators of these acts and law enforcement, and some of the DNA results obtained by the FBI Laboratory.

This presentation will impact the forensic community and/or humanity by providing insight to some of the inner workings of one of the most well-known serial killer cases in recent history.

The series of sniper attacks that occurred in October 2002 in Maryland, Virginia, and the District of Columbia caused region-wide fear and tension and affected the lives of millions of residents in the area. This presentation will provide insight into the sequence of events surrounding the sniper attacks, some of the contacts that took place between the perpetrators of these acts and law enforcement, and discuss some of the results obtained by the FBI Laboratory. Specific emphasis will be placed on the DNA examinations conducted and the unique items and examinations that yielded probative DNA typing results.

DNA, STRs, Serial Killersg

BS3 TV Crime Dramas and Trial Strategy (The Answers in 60 Minutes Without Messing Your Makeup or Challenging Your Deodorant)

*Judith G. Fordham, BSc, LLB**, Murdoch University, School of Biological Sciences and Biotechnology, Murdoch, WA 6150, Australia; and *David N. Khey, MS, MA**, Department of Criminology, Law, & Society, University of Florida, 201 Walker Hall, PO Box 115950, Gainesville, FL 32611-5950

After attending this presentation, attendees will gain "inside knowledge" from three post trial interview studies; two carried out in

Western Australia and one in the United States. These insights will provide rare and reliable information about what jurors love and what they hate about judges, lawyers, courtrooms, defendants, and other jurors. These projects will also illuminate the elusive question "Does the 'CSI Effect' exist?" directly from the individuals that are supposedly most impacted by it – the jurors themselves.

This presentation will impact the forensic community and/or humanity by helping attorneys and expert witnesses recognize, if not their own habits good and bad, the habits of others, and for the first time become aware of just how much jurors notice. This must (in a light hearted and entertaining way) help us all "lift our game."

Television crime shows have had a huge impact upon the public. Aside from educating potential jurors in forensic science (real or imagined), the shows have purportedly produced special and perhaps unachievable expectations of attorneys.

One of the presenting authors, a senior criminal trial lawyer and Associate Professor in Forensic Science, has interviewed at length over 100 jurors (and counting) about their deliberative process, what they think of the more or less competent attorneys, experts, and judges in the trial (be prepared for some colorful language), how they react to intimidation and violence in the public gallery, and how they deal with the rogue juror, amongst a host of other insights.

These interviews have been undertaken as part of two studies: the first relating to expert evidence in trials, and the second about the effect of intimidation on the jurors themselves and upon their verdicts. Formal findings have been and will be published from these studies; however, an enormous amount of additional material has been volunteered by jurors. Some of this additional material will be shared at the Breakfast session.

The other presenting author, a doctoral candidate in Criminology from the University of Florida, will proffer an overview of a comprehensive study on media and television's affects on American jurors in both local and Federal courts, and both civil and criminal trials. This project interviewed over 500 jurors in Florida, Tennessee, and Nevada via a survey instrument and a telephone follow-up primarily to determine jurors' perceptions of forensic science evidence and testimony with relation to media and television exposure.

Amongst the fascinating information presented is juror poetry, jurors' views of what training is essential for jury duty, and their reactions to aggressive cross-examination and judicial jokes. Some of the "pop psychology" relied upon by lawyers when presenting to juries will be debunked, and the true meaning of "beyond reasonable doubt" revealed!

This presentation will also provide comments from real jurors after real trials about the impact the CSI-type television shows have had on them, their deliberations and their verdicts, thus, providing a realistic framework for dealing with presentation of evidence.

Light will be shed on many issues. Can jurors put prejudice to one side? If a judge tells them to ignore inadmissible material, can they do so? Do they need to attend alternative dispute resolution classes before doing jury duty? What private investigations do they carry out during a trial (against strict instructions)? What questions do they want to ask? How do they fill gaps if their questions are not answered? Does jury duty change jurors' lives? Should there be upper or lower age limits for jury service?

Should defense avoid teachers as they are authoritarian? Will middle aged conservative women be fair to bikers and (alleged) organized crime figures? Do jurors horse trade with multiple charges or alternative verdicts? Do you want an intelligent jury or a dumb one or does it depend on the nature of the crime or defense? Can information successfully be kept from jurors? Do jurors regret their decisions later? If so when and why?

TV Dramas, CSI, Trial Strategy

BS4 Anatomy of a Cold Case: How to Revive a Cold Rape Case After 32 Years

Melissa Mourges, JD, and Martha S. Bashford, JD*, New York County District Attorney's Office, One Hogan Place, New York, NY 10013*

After attending this presentation, attendees will understand the methods and challenges involved in the re-trial of a 32 year old rape case, using new technology ranging from the Internet to CODIS databases.

This presentation will impact the forensic community and/or humanity by contrasting the use of cutting edge DNA science with antiquated rape evidence laws and teach lawyers how to make ancient evidence speak to today's juries.

It was June 26, 1973. Twenty-three year old Kathleen Ham, living in her first New York City apartment, was awakened at 5:00 a.m. by a noise. She went to the window and a man lunged inside. He threw her onto the bed, placed a knife taut against her neck, slicing her skin. He raped her, and then rummaged through her purse, stealing all the money she had, \$4 in cash.

Her screams caused a neighbor to dial 911. Two policemen arrived. Officer Mingola climbed out the neighbor's window onto the fire escape of Kathleen's apartment. Officer Snipes waited outside her front door.

The rapist saw Mingola in the window and made a dash out the door, past Snipes and onto the street. Snipes gave chase until the rapist disappeared over a fence. The police grabbed him one street over. He had Kathleen's money in his pocket. His name was Clarence Williams.

Williams made bail, and, while awaiting trial, he shot and raped another woman in Queens. Then he went to trial for his attack on Kathleen Ham. The jury hung, 11 to 1 for conviction. The defense was: he didn't do it, and even if he did, the victim was a slut. The jury found against him in Queens, but his conviction was overturned. While awaiting retrial in both cases, he jumped bail in 1978. No one heard from Clarence Williams again.

Until ... 2004, when he tried to purchase a gun from a shop in DeKalb County, Georgia. A background check revealed the warrants, and Williams, now calling himself Omar Abdul Hakkim, was brought back to New York for trial.

His trial folder had been sitting in municipal archives for over 30 years. When prosecutors pulled the file, they found the victim's underpants and the \$4 in cash inside. The underpants went to the DNA lab of New York City's Chief Medical Examiner. Scientists developed a male DNA profile that matched Clarence Williams. Not only that, but when the profile was uploaded to the National CODIS database, they found matches to 21 unsolved Maryland cases and two from New Jersey.

The trial garnered national attention, and presented incredible challenges. First, how to find the victim, and tell her she was going to face her attacker yet again? How to find the officers, long retired, and uncover their memories of events 30 years in the past? How to deal with records of medical procedures before there were such things as rape evidence kits or victim advocates? How to structure a rape trial in 2005 to deal with the application of long-dead rape evidence concepts such as a corroboration requirement and "earnest resistance?"

Senior Manhattan Assistant District Attorneys Martha Bashford and Melissa Mourges successfully tried Clarence Williams in November 2005. The case was featured on NBC's national news show Dateline. Kathleen Ham, now a lawyer, became a national spokesperson for victims' rights and a moving force behind two recent changes in New York law: a major expansion of the DNA databank and elimination of the statute of limitations for rape.

DNA, Rape, Trial

BS5 Washington, DC Area Serial Arsonist Investigation — The Laboratory Perspective

Raymond J. Kuk, MS, and Leanora Brun-Conti, BS, Bureau of Alcohol, Tobacco, Firearms, and Explosives, Forensic Science Laboratory - Washington, Beltsville, MD 20705; and Karolyn L. Tontarski, MA, Montgomery County, MD Police, Crime Laboratory, Rockville, MD 20850*

The goal of this presentation is to discuss a significant serial arson investigation from the laboratory perspective, including the identification of the incendiary device components and the investigative leads they provided. In addition, the process for recovering DNA from burned wick material will be discussed.

This presentation will impact the forensic community and/or humanity by describing the processes used by the laboratory in analyzing a significant serial investigation.

From June 2003 until April 2005, federal, state, and local investigators in the Washington, DC metropolitan area worked diligently to apprehend a serial arsonist. The arsonist would typically strike single family homes in the early morning hours while the residents slept. An incendiary device would be placed on the porch of the home by the front doorway, effectively blocking egress.

The multi-agency task force developed a protocol for responding to possible serial arsonist scenes. As part of the protocol, investigators would respond to the scene, collect the remnants of the device, and deliver the evidence to the laboratory within hours of the incident. The components of each device were examined to determine if the incident could be associated with the serial arsonist. The devices used by the serial arsonist were relatively simple. The basic construction consisted of a one gallon plastic jug partially filled with gasoline; a wick; and a plastic bag. During the early months of the investigation, the plastic jug was usually a fruit juice or water container. Throughout the series of fires, the wick was either socks or clothing items. Additionally, the jug and wick were placed in a plastic bag or bags to conceal the device. However, during the first few months of the investigation, there were no solid investigative leads.

Investigators received a break in September of 2003 when some young men returning home early in the morning discovered an individual sitting on their front porch. The boys chased the individual away. They then dropped a friend off before returning to their house. When the young men returned home, they found a device sitting on their front porch. The police were called, and the police, in turn, contacted the task force. The witnesses provided a physical description of the suspect. In addition, laboratory personnel recovered a hair from inside the intact device recovered on scene. The hair was suitable for nuclear DNA, and a profile was generated.

Several other fires were set over the next 15 months. The arsonist also escalated his targets to include apartment buildings. During this time, the laboratory continued to examine the devices, but laboratory personnel also started to select suitable samples for DNA analysis. The subsequent DNA analysis was used to link four separate incidents. One of the samples led investigators to a potential suspect. This suspect was questioned and voluntarily submitted a DNA sample – which matched the linked incidents. The suspect was arrested in April of 2005. A plea agreement was signed within two weeks of the arrest. The suspect plead guilty to seven incidents, including two deaths. The Washington, DC area serial arsonist is currently serving life plus 135 years and 10 months in federal custody. This presentation will discuss the laboratory's approach in examining the device remnants, the investigative leads provided by laboratory analysis, and the selection of appropriate materials from incendiary devices for DNA analysis.

Serial Arson, Incendiary Device, DNA

BS6 Problems in the Investigation, Prosecution, and Defense of Healthcare Practitioners Who Systematically Kill Their Patients

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After attending this presentation, attendees will one, understand evidentiary competence in prosecuting serial healthcare killers; two, become familiar with some "best practices" in prosecuting these cases; and three, share difficulties in defending or prosecuting cases of clusters of suspicious deaths.

The problem of healthcare associated serial murder is increasingly identified in countries with high-tech healthcare. The prosecution of these cases is complex, costly, and not always successful. This presentation will impact the forensic community and/or humanity by offering best practices and lessons learned from a number of cases.

The presenters, a physician/toxicologist from the United Kingdom and a nurse/ attorney from the United States will present, and draw conclusions from, a number of cases from their respective countries where healthcare professionals have been prosecuted for the murder of patients in their care.

The presenters have published data on 90 prosecutions of nurses, doctors, aides, and other health professionals since 1970. The total number of victims who died while in the care of a prosecuted practitioner is over 2,000. These cases are still relatively uncommon compared to other types of homicide. However, one concern is that in most detected cases, a number of deaths occur before suspicions are aroused. The typical case involves an increased number of cardiopulmonary arrests on a particular unit that are ultimately linked to presence of a specific nurse or other healthcare provider.

Case studies that illustrate a "profile" of serial healthcare killers include the following common themes:

1. A healthcare provider who loves the limelight and thrives on the excitement of critical incidents (one nurse confessed that he caused "codes" because he was like the firefighters who set fires).
2. Practitioners who have a history of falsifying their credentials and falsifying life events.
3. A history of Munchausen's Syndrome, or MSBP.
4. Sadistic, sociopathic practitioners who predict when patients will die, or kill those patients who are demanding or "whiny."
5. Work on the evening or night shift.
6. Have difficult relationships with intimates and co-workers.
7. Are often described as "excellent practitioners with good life-saving skills."

The investigation of such cases can be very resource intensive, and the high intelligence of the suspects makes careful planning of their interview mandatory. Downstream monitoring of the interview by an appropriate healthcare professional can be invaluable as can the incorporation into the investigative team of police officers with nursing or other healthcare qualifications.

Video footage of some of the convicted nurses will be shown. Best practices from some of the more successful prosecutions will be discussed along with lessons learned from some unsuccessful prosecutions. The use of statistics, toxicological evidence, eye-witness accounts, and profiling will be critiqued.

The defense will usually be competent and well funded; extra-curial factors, whether or not introduced deliberately by the defense, will have to be anticipated by the prosecution team.

Healthcare, Murder, Prosecution

BS7 Damaged Coral Reefs – A New, Fascinating, and Decidedly Edgy Dimension to CSI

Kenneth W. Goddard, MS, National Fish & Wildlife Forensics Laboratory, 1490 East Main Street, Ashland, OR 97520*

After attending this presentation, attendees will understand the interwoven complexities of the natural and human-initiated assaults that are killing vast areas of the world's coral reefs, as well as the mind-boggling — and occasionally amusing — difficulties of investigating these damaged reefs as crime scenes. Attendees will also learn how international agencies responsible for coral reef preservation intend to use modified terrestrial crime scene investigation techniques to accomplish their goals.

This presentation will impact the forensic community and/or humanity by providing awareness of a new crime scene category requiring the application of forensic and CSI techniques to help preserve a critical environmental habitat on an international scale.

The first thing a novice coral reef crime scene investigator learns is that virtually every protocol or technique routinely employed at a terrestrial homicide crime scene does not work well (if at all) in a marine environment. Among many other things: the scene perimeter cannot be easily established with lengths of rope or tape, scene notes cannot be written in ink, and the 'body' — which may or may not be dead or dying, depending on any number of definitions — cannot be moved for eventual autopsy.

To determine cause-of-death, collect relevant evidence, and to eventually link suspect, victim and crime scene, coral reef investigators must learn to adapt standard CSI techniques to a marine environment; and in doing so, pay close attention to the unforgiving limits of SCUBA diving while dealing with escalator-speed currents ... all the while keeping a wary eye out for things that sting and bite.

Coral Reefs, CSI, Environment

BS8 Thomas Krauss Memorial Bite Mark Breakfast: New ABFO Bite Mark Guidelines

Jon C. Dailey, DDS, 1178 Ohio Street, #2, Bangor, ME 04401*

By attending this presentation, attendees will learn the most recent update of the American Board of Forensic Odontology's (ABFO) Bite mark Methodologies Guidelines.

This presentation will impact the forensic community and/or humanity by increasing continuity between those analyzing bite marks and presenting their results in a court of law.

Attendees will learn the specifics of the ABFO Bite Mark Guidelines modifications, the rationale for updating the guidelines and the process that was used in the modification process.

Forensic odontologists should be in accord not only in bite mark data collection and analytic protocols, but also in the terminology used when discussing bite mark comparisons with attorneys, judges, and juries. The guidelines are not meant to stifle the development of new valid techniques that meet the criteria of the scientific method. It is, however, the intention of the American Board of Forensic Odontology (ABFO) as a credible body of experts to present clear and unified recommendations as to what its members and other forensic odontologists imply when they state a conclusion and the level of confidence regarding those conclusions. This will help avoid confusion in the minds of juries charged with determining the guilt or innocence of those individuals on trial for violent crimes.

Standardized ABFO bite mark methodology and recommended terminology was first begun in 1984, but they have not undergone major revisions in the last ten years. The ABFO Bite Mark Committee was charged with making recommended revisions to the guidelines during the AAFS Meeting in Seattle in 2006, which were ultimately adopted by the membership at large. The recent changes to the existing ABFO bite mark guidelines will be outlined in this presentation, and the process used in revising them will also be discussed. These revisions include standards concerning bite site and suspect evidence collection techniques and controls, specific degrees of confidence that an injury has been determined to be a human or animal bite mark, bite mark analytical and comparison techniques, and standardized terminology related to the evaluator's confidence in the relation of a bite mark to a particular suspected biter.

ABFO, Bite Mark, Guidelines



L1 **Trials of the Expert Witness: From Lycanthropy to Locard and the Legacy of Sherlock Holmes**

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After attending this presentation, attendees will gain a heightened understanding of the responsibilities of an expert witness and a healthy respect for the consequences if those responsibilities are ignored. This presentation will also provide information on historical sources for instructive and entertaining material that is applicable today and suitable for presentation to both lay and professional audiences.

This presentation will impact the forensic community and/or humanity by increasing consciousness about the responsibilities of expert witnesses, and added awareness of historical materials that can be used to explain forensic specialties to lay and professional audiences.

The presentation of expert opinion has been an integral part of criminal trials from the beginning of legal history, sometimes with unfortunate results. Specialists in the diagnosis of lycanthropy and witchcraft—such as Sprenger, Kraemer, and Jean Boin—testified frequently before medieval courts, inevitably achieving rousing victories for the prosecution.

In the 19th and early 20th centuries, as forensic science struggled to emerge from the carapace of superstition, the ideal of the objective, impartial expert witness was born, further developed by scientists such as Edmund Locard and his fictional counterpart, Sherlock Holmes. It is an ideal we strive for today, not always successfully.

This seminar will trace the historic role of the expert witness, and provide intriguing, entertaining, and sometimes cautionary tales of forensic testimony and scientific misadventure.

Expert Witness, Sherlock Holmes, History

L2 **Forensic Investigations Into “The Missing”: Principles and Guidelines From the International Committee of the Red Cross**

Morris Tidball-Binz, MD, Shuala M. Drawdy, MA*, and Ute Hofmeister, MA, International Committee of the Red Cross, 19 Avenue de la Paix, Geneva, 1202, Switzerland*

After attending this presentation, attendees will gain awareness of the principles guiding forensic investigations into the whereabouts of those missing as a result of armed conflict or internal violence, with practical examples of their implementation worldwide, including challenges and opportunities for forensic professionals.

This presentation will impact the forensic community and/or humanity by demonstrating how observing the humanitarian implications of their actions and following existing guidelines for investigations into the whereabouts of the missing, forensic practitioners help fulfill the right of families to know the fate of their loved ones and to relieve their suffering. At the same time, the scope and action of the forensic sciences are developed and expanded by the participation of forensic practitioners in an ever-expanding global setting.

Forensic sciences play an important role in helping victims of armed conflict and other situations of armed violence to seek redress, and in exposing the truth about violations of human rights and humanitarian law. As a result, since the early nineties, a series of forensic standards have been developed by the concerned scientific community and adopted by the United Nations, to guide investigations into deaths in custody, mass graves and torture in order to help improve the documentation of these serious crimes.¹

Forensic sciences are also increasingly used worldwide to help clarify the fate of people missing as a result of armed conflict and other situations of widespread armed violence. Under international humanitarian law,² families have the right to be informed of the fate of missing relatives. However, until recently, no guidelines existed for this specific purpose.

In response, the International Committee of the Red Cross (ICRC) launched a major initiative in 2002 to help resolve the tragedy of The Missing worldwide and to assist their families. The aim is to heighten awareness among governments, the military, international and national organizations and the general public about the tragedy of people unaccounted for and the anguish experienced by their families by creating and making available tools for action and communication in order to ensure accountability on the part of the authorities, to better assist the families of the missing and to prevent further disappearances. In addition, in 2003, the ICRC held an international conference of experts which adopted a wide range of recommendations based on existing best practices, including principles and guidelines for forensics investigations into the missing.³ These principles and guidelines include the applicable legal and ethical framework, the role of bereaved relatives, collection of antemortem data, proper recovery and storage of mortal remains, identification methods and techniques, and principles of management. These principles and guidelines will be outlined in this presentation, with examples of their implementation in different ICRC operational contexts, together with a summary of trends, challenges and opportunities for the forensic profession.

The International Committee of the Red Cross (ICRC),⁴ founded in 1863, is an independent and neutral organization ensuring humanitarian protection and assistance for victims of war and armed violence worldwide. The ICRC has a permanent mandate under international law to take impartial humanitarian action on behalf of prisoners of war, the wounded and sick, and civilians affected by conflict. The ICRC is at the origin of both the International Red Cross/Red Crescent Movement and of international humanitarian law, notably the Geneva Conventions. References:

¹ e.g. Manual on the Effective Investigation and Documentation of Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (Istanbul Protocol); Manual on the Effective Prevention and Investigation of Extra-Legal, Arbitrary and Summary Executions (Minnesota Protocol)

² Geneva Conventions I-IV and their Additional Protocols 1 & 2.

³ International Conference of Governmental and Non-Governmental Experts (Geneva, 19-21.02.2003), Outcome in: The Missing: Action to resolve the problem of people unaccounted for as a result of armed conflict or internal violence and to assist their families.

⁴ www.icrc.org

International Committee of the Red Cross (ICRC), Missing Persons, International Humanitarian Law



W1 Pre- and Post-Blast Detection and Analysis: Looking for the Needle in the Haystack

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After attending this presentation, attendees will be familiar with canine techniques for the detection of explosives, understand the training, selection and handling of explosives detection canines as well as those specific chemicals to which they are likely to respond, be aware of the emerging ability to utilize human scent remaining on post-blast debris to associate individuals with devices, and understand the limitations and capabilities of current canine and instrumental analysis methods.

This presentation will impact the forensic community and/or humanity by promoting the application of canine and instrumental technologies in the area of explosives detection and analysis both pre- and post-blast.

Explosives detection and analysis is at the forefront of combating both domestic and foreign terrorism. Canines have long held the top position of the best real-time explosives detection system; however, their capabilities can be complimented by instrumental techniques to enhance the evaluation of explosive devices. This workshop, held offsite at Lackland Air Force Base, will assemble analysts and researchers from across the explosives community to present a selection of papers covering an array of topics pertaining to the location and analysis of explosives and post-blast debris. A novel application of utilizing human scent from exploded car bomb to identify the bomb maker will also be presented. Additionally, the afternoon section of the workshop will allow for tours of the TSA's Canine Training Laboratory as well as their Puppy Program.

Canine, Instrument, Explosives Detection

W2 Pharmacogenomics as Molecular Autopsy — An Adjunct to Forensic Pathology and Toxicology

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After attending this presentation, attendees will be able to relate the principles of pharmacogenomics to the concept of gene dose drug therapy

and the contribution of genetics to drug toxicity. By using case studies, pathologists and toxicologists would interpret pharmacogenomic test results by knowing their usefulness and the limitations. Pharmacogenomic test results need to relate to the autopsy findings and toxicology, hence, this molecular autopsy through pharmacogenomics becomes, an adjunct to forensic pathology and toxicology. Along with case history and other autopsy findings, pharmacogenomics might be used to explain acute or chronic drug toxicity. Finally, from the preliminary findings of a multi-center methadone pharmacogenomics study, the participant will be able to plan for coordinated studies with data transfer through the internet using readily available database program, and to evaluate the gene dose effect on methadone fatalities.

This presentation will impact the forensic community and/or humanity by demonstrating how with the emergence of genomic medicine, the genetic contribution to drug toxicity may be helpful to interpret drug related toxicities and drug-drug interaction in forensic toxicology. The findings will strengthen the approach of antemortem drug therapy by the emerging classification of patients according to genotype – gene dose therapy, and to minimize drug toxicity. Overall, the findings would enhance the practice of Personalized Medicine.

With the emergence of Genomic and Personalized Medicine, pharmacogenomics may be used to offer gene-dose drug therapy by establishing the genes involved in drug metabolism, transport, and receptor. Pharmacogenomics may be defined as the optimization of drug therapy based on individual genetic variation. Phenotypes of wild, intermediate and poor metabolizers correlate to individuals with zero, one – heterozygous, and two – homozygous genetic variations, with resultant decreasing dosage requirement. For forensic pathology and toxicology, the genetic contribution to drug toxicity may be helpful to interpret drug related toxicities and drug-drug interaction. The findings will help antemortem drug therapy by classifying patients according to genotypes – gene dose therapy, thus minimizing drug toxicity. Following the principles of pharmacogenomics and the concept of gene-dose therapy, the application of pharmacogenomics is illustrated from two perspectives – forensic pathologist and toxicologist, supplemented by case studies. Case selection criteria would be proposed based on autopsy findings and case history. By genotyping drug metabolizing enzyme genes such as cytochrome P450 (CYP) 2D6, 2C9, 2C19, 3A4/5 and others, pathologists and toxicologists would interpret pharmacogenomic test results by knowing the usefulness and the limitations, as well as the need for interpreting the result with autopsy findings and toxicology – the use of pharmacogenomics as molecular autopsy, an adjunct to forensic pathology and toxicology. For some cases, pharmacogenomics might be used to differentiate between acute or chronic drug toxicity. Finally, from the preliminary findings of a forensic pathology-toxicology multi-center methadone pharmacogenomics study, the participants will be able to plan for coordinated studies with data transfer through the internet using a readily available database program, and to evaluate the gene dose effect on methadone fatalities. The findings on methadone death certification will provide a comprehensive assessment on the usefulness and limitation of using pharmacogenomics for interpreting drug toxicity. Thus, the postmortem pharmacogenomics findings would enhance the antemortem practice using pharmacogenomics for Personalized Medicine.

Molecular Autopsy, Pharmacogenomics and Personalized Medicine, Methadone Drug Toxicity and Interactions

W3 Newer Analytical Techniques: Applications in Forensic Toxicology

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After attending this presentation, attendees will achieve the following learning objectives from the four presentations: understand the operational aspects of a micro fluidic switch in gas chromatography; be able to develop procedures using two dimensional GC systems; be able to incorporate two dimensional GC into routine toxicological testing; understand the basic theory and principles underlying the analysis of specimens using isotope ratio mass spectrometry; have obtained expanded knowledge of the applications of isotope ratio mass spectrometry that are relevant to forensic toxicology; understand the basic theory and principles of time of flight (TOF) mass analyzers; be able to describe the theoretical advantages of TOF mass analyzers over quadrupoles (including: higher resolving power, mass accuracy, and full scan sensitivity); be familiar with practical applications of TOF in the forensic toxicology laboratory; understand the theory of the DARTTM (Direct Analysis in Real Time) source coupled to a TOF mass spectrometer for forensic applications and understand how the DART source, coupled to a TOF, can be used for analysis of liquid and solid samples on surfaces.

This presentation will impact the forensic community and/or humanity by expanding our knowledge-base regarding the use of newer technologies in forensic toxicology settings.

Forensic toxicology is a dynamic discipline that draws upon techniques and instrumentation from diverse scientific fields. Methods and instrumentation for the identification and quantitation of toxic chemicals and their metabolites in biological specimens must continually evolve so that laboratories can meet challenges presented by newer drugs and matrices that require increasingly lower thresholds for detection. In this workshop, four speakers will discuss and present practical applications of newer mass spectrometry-based techniques in forensic toxicology laboratories. The first presentation, by Dr. Christine Moore will focus on the operation of the Deans switch micro fluidic systems in gas chromatography. The theory of use, method development, maintenance, and applications for the field of toxicology will be discussed. Dr. Matthew Slawson will then focus on the use of gas chromatography - combustion isotope ratio mass spectrometry, including the basics of the theory behind this technique and specific examples of its use in forensic toxicology, particularly as they relate to detection of doping in sport. The third presentation, by Dr. Chad Borges, will focus on high resolution mass spectral techniques, such as time-of-flight (TOF) mass spectrometry, that are beginning to make an impact in the field of small molecule forensic analysis. This discussion will include an introduction on how the TOF mass analyzer works, the theoretical advantages and disadvantages of TOF over quadrupoles, and practical forensic situations where TOF may provide an advantage over traditional quadrupoles mass analyzers. Dr. Eshwar Jagerdeo will then further extend this discussion by presenting an overview of DARTTM (Direct Analysis in Real Time) source coupled to a TOF mass spectrometer for forensic applications. The research presented will demonstrate the use of this source for analysis of liquid and solid sample on surfaces. The focus for this presentation is in the following areas: sample introduction techniques, positive-ion and negative-ion detection, accurate mass measurements for qualitative analysis, and quantitative analysis.

Time-of-Flight Mass Spectrometry, Forensic Toxicology, Analytical Techniques

W4 A Primer and Update on Digital Evidence

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After attending this presentation, attendees will gain an overview of current issues and practices in the digital forensic community and have an opportunity to actually utilize a variety of forensic tools and techniques in conducting a mock examination.

This presentation will impact the forensic community and/or humanity by providing the forensic community with a deeper understanding of the emerging forensic field of digital forensics and allow for its integration into traditional forensic disciplines.

This workshop will provide attendees with an overview of current practices in the digital forensic community and an opportunity to utilize a variety of forensic tools and techniques in conducting a mock examination.

Digital evidence is information of probative value, stored or transmitted in binary form. The physical form of this evidence can be in the form of hard disks, optical disks, USB drives, digital camera, and audio media. The forensic examination of digital evidence has become one of the fastest growing disciplines in forensic science. This discipline is being practiced in traditional crime laboratories, dedicated digital forensic laboratories, law enforcement agencies, and consultancies of all sizes.

As everyone knows, information technology evolves at a frantic pace. Practitioners in digital forensics are constantly challenged to keep up with technology and techniques to successfully conduct examinations. Practitioners of other forensic disciplines are routinely coming into contact with the physical evidence (digital storage media) used to store digital evidence. It is important that managers and traditional forensic practitioners are able to integrate this new discipline into their organization.

This workshop will provide an opportunity for managers, current practitioners, and individuals who are just interested in this emerging field to hear updates on many of the evolving issues.

The morning portion of the workshop will feature a series of presentations on "hot topics" in the digital evidence field. The distinguished presenters will discuss management, funding, quality assurance issues, current tools and techniques used in this field, laboratory accreditation, practitioner certification, competency and proficiency testing, available training and digital evidence education programs. Each presentation will allow for questions and an open discussion of the issues.

In the afternoon session, the participants will be guided by experienced instructors, who will allow participants to utilize actual tools and techniques to conduct a mock examination from evidence collection through imaging, examination, analysis, reporting, and testimony.

Digital Evidence, Computers, Media

W5 Mitochondrial DNA Analysis: The Foundation and the Fundamentals at the Leading Edge

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The goal of this workshop is to provide attendees with knowledge to more effectively use mitochondrial DNA (mtDNA) in forensic applications.

This presentation will impact the forensic community and/or humanity by targeting those individuals who have some operational knowledge of mtDNA and want to learn how to work with both typical and unusual samples. A major portion of the workshop will focus on helping the attendees better understand the intricacies of data analysis.

The Armed Forces DNA Identification Laboratory (AFDIL) has been a leader in the field of mitochondrial DNA analysis for over 14 years. Working with the Joint POW/MIA Accounting Command – Central Identification Laboratory (JPAC-CIL), one of AFDIL's missions has been the identification of missing United States service members from past military conflicts using mitochondrial DNA analysis (mtDNA). The presentations in this workshop will strive to create a learning environment for attendees who may benefit from the combined knowledge base of the speakers and consequently the groundwork laid by AFDIL in this difficult field.

Forensic DNA laboratories around the world are investigating the uses of mtDNA, particularly for cold or missing persons cases. Unfortunately, many are unprepared for the challenges that come with mtDNA analysis. The goal of this workshop is to expose attendees to the day-to-day workings of an mtDNA lab and the intricacies of processing degraded or difficult samples. After participating in the session, attendees will have a greater understanding of how to use mtDNA effectively in a forensic setting.

Speakers at the workshop will present on a variety of topics that will be useful to the mtDNA neophyte as well as veteran mtDNA analysts who would like to increase their understanding. We will discuss such fundamental topics as how to organize laboratory space, prevent contamination, and create an efficient flow of data and materials, particularly in the face of high volumes of sensitive samples. Sample selection is a necessary part of any forensic laboratory. Effective sampling strategies for skeletal remains should be developed that increase the yield and the quantity of mtDNA recovered as the remains available are often limited and/or of poor quality. Examination of over 5000 skeletal samples has provided procedures for the optimal selection of skeletal elements for mtDNA analysis. These tactics, as well as new extraction techniques for maximizing mtDNA recovery, will be discussed.

The afternoon session will deal with the unique challenges in managing quality control and validation for low-copy DNA laboratories and the new techniques that are on the horizon for both mtDNA and degraded DNA. Forensic DNA analysis is a rapidly changing field. This frenetic development increases the need for any lab to have dedicated groups for research, validation, and quality control. Individuals in these groups can more easily explore new methods, develop them for implementation into casework, and quality control required reagents and instrumentation without removing casework scientists from active cases.

The session will close with an interactive presentation of real casework data and a discussion of the calling criteria for mtDNA including such sequencing incongruities as point and length heteroplasmy, in/dels, and “Taq error.” Sequencing data can be difficult to interpret when the

frame of reference is limited. AFDIL reports approximately 800 skeletal samples a year consisting of several thousand sequencing samples per month. As a result, speakers will be able to provide attendees with real data for active discussion and interpretation, with presentation of actual resolved incidents. Attendees are encouraged to augment this topic by bringing examples of difficult data for discussion.

The views expressed herein are those of the authors and not necessarily those of the Armed Forces Institute of Pathology, the U.S. Army Surgeon General, nor the Department of Defense.

Mitochondrial DNA, DNA Analysis, Skeletonized Remains

W6 Proving a Priest Killed a Nun: The Role of Forensic Science in Successfully Resolving a 26-Year-Old Cold Case

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After attending this presentation, attendees will be better able to recognize and evaluate the strengths and weaknesses inherent in cold cases – especially cases where DNA does not “solve” the crime but could be used to confuse the jury. These include:

- Reviewing the implications of deposition of extraneous DNA in “pre-DNA fingerprinting” times by personnel who didn't glove or mask – a situation exacerbated by current DNA technology that recognizes increasingly minute amounts of trace DNA.
- Re-evaluating original crime scene photos and investigative reports and locating surviving witnesses.
- Re-examining evidence using non-DNA techniques such as analysis of weapon signatures in bone and bloodstain transfer pattern analysis, and then narrowing the field by multiplying successive class characteristics instead of focusing on one class characteristic in isolation.
- Constructing a time (and space) line for witnesses and the alleged perpetrator.
- Using modern audiovisual techniques in the courtroom to enable the jury to understand spatial and temporal relationships as well as to more effectively present the examination and comparison of evidence. In addition, the jury could be visually reminded of the contrast between the accused in the courtroom (looking elderly and frail at 68) and the appearance of the accused in 1980 (then 42) at the time of the murder of the elderly (72) victim.

As a consequence, attendees can then develop an investigative strategy and trial plan that can be used to overcome concerns about “circumstantial evidence” and resultant “reasonable doubt,” including Daubert hearings.

This presentation will impact the forensic community and/or humanity by presenting the successful conclusion of this 26-year-old case in the absence of DNA evidence, fingerprints, or eye-witnesses should

encourage other jurisdictions to pursue similar cases, thereby offering closure for families who have lost hope of ever getting justice for their loved ones.

The possibility that the original investigation was hampered by the Catholic Church raises ethical questions, but its successful prosecution in 2006 should enable other jurisdictions to open or re-open cases involving ritual or related abuse.

The very important nature of ritual abuse and its potential association with “Satanism” introduces practical as well as ethical considerations. Additional ethical concerns arise when there are reports of ritualistic abuse by the accused, involving other living victims and, in fact, pending civil suits.

In this instance, prosecutors were able to avoid references to “Satanism,” while at the same time realistic ritualistic context was provided by a canon lawyer from the Archdiocese of Chicago specializing in ritual and exorcism.

This case had all the usual cold case problems based on the passage of time. Witnesses, investigators and the original forensic pathologist were dead. Memories were uncertain. Some reports and evidence were lost. Biologic evidence had deteriorated.

These “usual” cold case concerns were compounded by the fact that the accused murderer (also the original main suspect), was a priest and the nun had been strangled and stabbed 31 times in the sacristy of a Catholic hospital on Holy Saturday morning in 1980. A number of ritualistic elements other than timing and location were present.

Other problems encountered included the need for the pathologist to testify not only to her post-exhumation autopsy findings but to the findings of the original pathologist (now deceased), lack of eye-witnesses to the actual crime, apparent Catholic hierarchy interference in the 1980 questioning of Robinson with present reluctant cooperation, rumors of cover-ups, lack of physical evidence and the general disbelief that such a thing could have occurred.

These problems were overcome through meticulous investigation resulting in layers of circumstantial evidence, beginning with examination of available records from 1980 and location of witnesses, some of whom came forward upon learning the case had been reopened. Cold Case Unit Investigators retrieved evidence collected in 1980, including a possible weapon (a distinctive letter opener belonging to the priest) and a blood stained altar cloth. A Crime Scene Unit Detective, also an artist, noticed the altar cloth had bloodstain transfer pattern imprints of several aspects of the letter opener. In addition, nine symmetrically placed stabs through the cloth formed an inverted cross on the nun’s chest. These findings provided a basis for reopening the case with the arrest of Father Gerald Robinson and the exhumation of Sister Margaret Pahl’s body.

In 1980, when first questioned about the murder, Father Robinson indicated that the letter opener was never out of his possession. The next step was to more firmly link the letter opener to the bloodstain transfer patterns on the altar cloth by calling in a “second tier” of experts. Bloodstain transfer linkages were in terms of class characteristics, rather than individual characteristics (a specific instrument), but both tiers of experts, under the guidance of the prosecutor, were able to narrow the field by multiplying successive class characteristics in somewhat the same way that individual genetic loci are combined to form a distinctive genetic profile.

A post exhumation autopsy provided material for a DNA profile of Sister Pahl, and an opportunity to examine the remarkably well-preserved stab wounds. All bone and cartilage underlying the stab wounds was examined for possible weapon signatures. Three punctures had an unusual and distinctive diamond shape. Examination of the tip of the letter opener several days later revealed consistency with the distinctive diamond shape of skeletal punctures. Comparison of these bone punctures with those produced by inserting the letter opener into clay, followed by careful approximation of the suspect weapon tip to the shallow, open mandible puncture further established consistency. This consistency was verified by another “second tier” expert specializing in skeletal trauma – sharp force in particular - who tested the fit of a cast of the letter opener tip within a cast of the defect in the mandible. This again was a class, rather than individual, characteristic, albeit a very distinctive one.

DNA could not be used to link the accused with the crime. In fact, the ability of modern DNA technology to detect minute quantities of DNA shed during a pre-DNA era when investigators and others did not take precautions was a hurdle that was overcome with appropriate expert testimony about contamination.

Testimony by an expert from the Archdiocese of Chicago on canon law, rituals, and exorcism demonstrated that the ritualistic elements of the crime and scene required specialized religious knowledge. A detailed timeline for the murder developed by investigators with the aid of witnesses demonstrated that Father Robinson was the only person with appropriate religious knowledge available to commit the murder within the defined time frame.

Before a 1980 photograph of the then 42 year old Father Robinson, the jury was asked to convict him of the murder of the 72 year old “Bride of Christ”—26 years late. They did.

Cold Case, Bloodstain Transfer Pattern, Weapon Signature

W7 Practical Homicide Investigation: Tactics, Procedures, and Forensic Techniques

Vernon J. Geberth, MS, MPS, PO Box 197, Garnerville, NY 10923; and Robert D. Keppel, PhD*, Seattle University, PO Box 222000, Seattle, WA 98122*

After attending this presentation, attendees will have an understanding of the practice and theory of professional homicide investigation; they should better understand pertinent legal decisions, multiple crime scenes, components of a murder investigation, cold case homicide investigations and how time and distance as solvability factors affect murder cases, the management of the homicide investigations and the processing of the homicide crime scene.

The instructors for this course have many years of practical homicide experience. Currently they both teach homicide investigation to law enforcement officers from around the country. That same information can be passed on to forensic scientists from all disciplines who attend the AAFS scientific meeting. This presentation will impact the forensic community and/or humanity by assisting forensic scientists in understanding the most modern techniques and procedures homicide investigators utilize to solve murder cases.

The Practical Homicide Investigation® and Sex-Related Murder Workshop will expand upon last year’s workshop entitled “Practical Homicide Investigation.” In the 2007 workshop, Commander Vernon Geberth and Dr. Robert Keppel will integrate and illustrate the tactics, procedures, and forensic techniques of practical homicide investigation to the investigation of sex-related murders. For homicide detectives, the book Practical Homicide Investigation® has been recognized as the benchmark and “Best Practice” model for professional death investigation. Contained within are protocols for detectives to follow in dealing with various types of death investigation. Now, the presenters will focus more narrowly on the often-troubling sex-related investigations. After experiencing the first workshop section, attendees will understand the investigative significance of fantasy in sex-related murders and procedures involved in the collection and preservation of physical evidence in sex-related death investigations. Following that presentation, a historical review of Modus Operandi and Signature cases and analysis procedures for determining the M.O. and signature characteristics of sex-murderers will take place. Specifically, follow-up investigative techniques will be given regarding rape, sodomy, lust murders, and serial murder investigations. And finally, a discussion will take place where the audience of attendees may ask questions of the presenters. The overall goal of the workshop is to provide comprehensive and practical information that will serve as an investigative guide to the investigation of sex-related murders as well as serial homicide.

Homicide Investigation, Cold Case Murders, Serial Murder

W8 Anatomy of a Wrongful Conviction: A Multidisciplinary Examination of the Ray Krone Case

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Upon completion of this workshop, participants will be able to identify and prevent potential mistakes, deficiencies, problems, and liabilities associated with casework. The participants will also learn the value of thorough evidence analysis and increased communication among other members of the criminal justice system. Finally, participants will learn how these wrongful convictions directly affect the lives of innocent people who are wrongly convicted.

This presentation will impact the forensic community and/or humanity by identifying the warning signs associated with wrongful convictions and the necessary steps in casework to prevent wrongful convictions. This will reduce the number of cases in which innocent people are wrongfully convicted.

This workshop will examine the wrongful conviction of Ray Krone who was accused, tried, and convicted twice in the 1991 homicide of Kimberly Ancona. Upon completion of this workshop, participants will be able to identify and prevent potential mistakes, deficiencies, problems, and liabilities associated with casework. The participants will also learn the value of thorough evidence analysis and increased communication among other members of the criminal justice system. Finally, participants will learn how these wrongful convictions directly affect the lives of innocent people who are wrongly convicted.

During the morning hours of Sunday, December 29, 1991, the nude body of a cocktail waitress, Kimberly Ancona, was found on the men's room floor of the CBS Lounge in Phoenix, Arizona. She had been beaten, stabbed multiple times, sexually assaulted and bitten on her neck and left breast. The evidence indicated that Ms. Ancona had closed the CBS Lounge at approximately 11:00 p.m. on December 28, 1991 and was cleaning the men's room when she was murdered.

While still at the crime scene, police were provided a tip from a witness who saw a Hispanic, or Native American man loitering near the rear doorway of the CBS Lounge during the early morning hours of December 29, 1991. In spite of this lead, the police immediately focused on Ray Krone, a Caucasian U.S. Postal Service Worker and U.S. Air Force veteran with no criminal record. Mr. Krone had become the focus of the investigation after another cocktail waitress at the CBS Lounge falsely reported to the police that earlier during the day, Ms. Ancona had told her that a man named "Ray," with whom Ms. Ancona alleged that she had a romantic interest, was coming to help Ms. Ancona close up the lounge. She also said that "Ray" and Ms. Ancona were then going to spend the night together. While still at the crime scene, two entries of the name "Ray" were found in Ms. Ancona's address book. One of the telephone numbers for a "Ray," was determined to be for Ray Krone, who was an acquaintance of Kimberly Ancona and had competed in dart tournaments with Ms. Ancona, some of which had occurred at the CBS Lounge.

Although there were shoeprints, fingerprints, hair, fibers, and blood found at the scene, the only evidence that appeared to connect Ray Krone to the murder of Kimberly Ancona was the bite mark found on Ms. Ancona's left breast. Armed with the information they had just learned

about Ray Krone from the cocktail waitress at the CBS Lounge, police went to his nearby residence and obtained a Styrofoam bite mark exemplar from Mr. Krone. An inexperienced, unqualified dentist, John Piakis, DDS, who had been invited to the scene by the police, visually compared the bite mark on Ancona to the Styrofoam bite mark exemplar from Mr. Krone and proclaimed that they were consistent.

Despite [a] his denial of any romantic involvement with Kimberly Ancona; [b] an alibi witness for the time Ancona was murdered; and [c] his complete cooperation with the police in providing them hair, blood, saliva, and bite mark samples, on December 31, 1991, Ray Krone was arrested and charged with the murder of Kimberly Ancona.

Based upon Dr. Piakis' lack of qualifications, the State of Arizona retained a board-certified Las Vegas based forensic odontologist, Raymond Rawson, DDS, who testified at trial that he was certain the bite mark on Ancona's breast matched Mr. Krone's dentition. After the defense's unsuccessful attempt to exclude a videotape used by Dr. Rawson to illustrate his opinion, or to obtain a continuance, the jury convicted Krone of first degree murder and kidnapping, but acquitted him of sexual assault. The judge sentenced Krone to death, after finding that the murder was committed in an especially "heinous and depraved manner."

On June 22, 1995, Ray Krone's conviction was reversed and remanded for a new trial. The court reversed Krone's conviction because of late disclosure of the videotape prepared by the State's dental expert, Dr. Raymond Rawson. According to the Arizona Supreme Court's en banc opinion, defense attorneys were not informed until the day before the trial that the prosecution intended to use the videotape labeled "Bite Mark Evidence Ray Krone." The court said, "The tape attempted to show a match between Krone's teeth and Ancona's wounds by overlaying the two. It took the dental casts, Styrofoam impressions, and CAT scans of the casts and overlaid them on the actual wounds. The tape presented evidence in ways that would have been impossible using static exhibits...The State's discovery violation related to critical evidence. We cannot say it did not affect the verdict." (State v. Krone, 182 Ariz. 319, 897 P.2d 621 (en banc, 1995). Dr. Rawson had used his videotape extensively during his testimony.

On re-trial, Ray Krone's hopes that justice would prevail where dashed when he was again wrongfully convicted and was sentenced to life in prison. The second jury was also swayed by the testimony of the State's dental expert, Dr. Raymond Rawson, despite testimony from several board-certified forensic odontologists that the bite mark on Ancona was not left by Ray Krone. Even the judge, who sentenced Ray Krone to life imprisonment instead of the death penalty, suspected that an injustice was being committed. After sentencing Mr. Krone, Superior Court Judge James McDougall wrote, "The court is left with a residual or lingering doubt about the clear identity of the killer."

In 2002, DNA testing was being routinely done on inmates within the Arizona Prison system who were maintaining their innocence. Krone's lawyers asked that Kimberly Ancona's tank top, through which one of the bites had been inflicted, be examined for saliva. Not only was saliva found, but further DNA analysis and comparison of the resulting profile against the Combined DNA Index System (CODIS) database, identified the donor as Kenneth Phillips, a 36 year-old Native American inmate in the Arizona State Penitentiary, Florence, Arizona. Phillips was serving time for attempted child molestation that he had committed three weeks after he murdered Kimberly Ancona. The Maricopa County Attorney's Office reported that the odds were 1.3 quadrillion to 1 that Kenneth Phillips was the contributor of the DNA found on Kim Ancona's tank top. In addition to the DNA evidence, previously unidentified latent fingerprints found at the murder scene were identified as those of Kenneth Phillips.

Ray Krone was released from Arizona State Prison, Yuma, Arizona on Monday, April 8, 2002. Mr. Krone was the 100th person released from prison based on exonerating evidence. In July 2006, Kenneth Phillips entered a guilty plea to the murder of Kimberly Ancona. Ironically, Dr. John Piakis, the dental expert who originally stated that Krone's dentition "was consistent" with the bite marks left on Kimberly Ancona, has now also opined that Kenneth Phillips "could not be excluded" as the person who left the bite marks.

In 2003, Mr. Krone began a civil action against Maricopa County and the City of Phoenix. As the civil case progressed, more problems were revealed with [a] the police investigation, [b] fingerprint analysis, [c] shoeprint analysis, [d] bite mark analysis, [e] hair analysis, and [f] blood analysis. On September 27, 2005, Maricopa County and the City of Phoenix reached an out-of-court settlement with the civil rights lawsuits that had been brought by Ray Krone.

A review of the case will show that, as in any system failure, several factors contributed to the wrongful conviction of Mr. Krone. Among these factors were a poor investigation; a lack of communication among the investigators, the crime lab, and prosecutors; errors and omissions in the criminalistic analyses; bite mark miss-identification; and ineffective assistance of counsel. Parts of the program will also focus on the analysis of key pieces of evidence that were initially missed and/or ignored which ultimately led to the identification, arrest, indictment, and conviction of Kenneth Phillips. The program will also cover the civil and criminal legal aspects of the case including the potential liability of forensic scientists involved in wrongful conviction cases. Finally, attendees will hear first hand of the horrors and impact a wrongful conviction has on an innocent person and his family.

This presentation will impact the forensic science community by allowing it to recognize warning signs associated with wrongful convictions and to take the necessary steps in casework to prevent wrongful convictions. This will reduce the number of cases in which innocent people are wrongfully convicted.

Errors, Omissions, Wrongful Convictions

W9 Principles of Forensic DNA for Officers of the Court

Kevin Lothridge, MS, Debra A. Figarelli, BS, and Robin W. Jones, BS, National Forensic Science Technology Center, 7448 Shepherd Ridge Court, Springfield, VA 22153; Christopher H. Asplen, JD*, 1329 Upper Stump, Chalfont, PA 18914; Jules Espstein, JD*, Widener University School of Law, 4601 Concord Pike, The Law Building, 4th Floor, Wilmington, DE 19803; Ronald S. Reinstein, JD*, Superior Court of Arizona, 201 West Jefferson Street, Phoenix, AZ 85003; and Glenn R. Schmitt, JD*, National Institute of Justice, 5611 James Gunnell Lane, Alexandria, VA 22310*

After attending this presentation, attendees will understand the biology of DNA; crime scene issues; introduction to the forensic DNA laboratory; assuring quality in DNA testing; understanding a forensic DNA laboratory report and DNA databases. Learning objectives for the afternoon session include pretrial DNA evidence issues; procedural considerations for the defense and prosecutor; trial presentation; jury issues; and expert witnesses.

This workshop was designed to serve finders of fact who are responsible for the prosecution, defense, or judicial action associated with criminal forensic DNA evidence. It defines DNA and the technologies used in forensic DNA applications. This presentation will impact the forensic community and/or humanity by addressing scientific evidentiary issues and legal considerations for attorneys and the judiciary that arise as a result of expanded uses of DNA evidence and DNA data banks to solve crime. This resource tool, combined with the subsequent training that is to be offered, will decrease nationwide training costs to Judges as well as District Attorney and Public Defender offices, ensuring that our courts are better equipped to manage forensic DNA evidence. Efficiencies will be realized in court systems throughout the country, including more effective adjudication of criminal cases containing biological evidence. Significant administrative cost savings will result from the increased numbers of plea bargains. Efficiencies will also be realized beyond the courts with increased coordination of requests for testing, pre-trial preparation, and expert testimony requirements, which collectively place significant burdens on the crime laboratory.

This two-part workshop was specifically designed for legal professionals who are responsible for the prosecution, defense, or judicial action associated with criminal forensic DNA cases – from investigation through adjudication and beyond. The workshop program will define DNA and issues associated with forensic DNA analysis and laboratory reporting. The program will also address evidentiary issues and legal considerations for attorneys and the judiciary that arise as a result of expanded uses of DNA evidence and DNA data banks to solve crime, for example. Multiple layers of content will be integrated into the workshop program to ensure that it can reach the widest audience; serving as an educational tool for those who have very limited knowledge, or as a refresher for those who have extensive experience managing forensic DNA cases. The workshop’s “blended learning” environment enables the audience to experience technical and legal content in a modular format, reinforced with dynamic animations and video. Participants will receive a free copy of the interactive, fifteen-module CD-ROM program.

Session one of the two-part workshop will cover topics including the biology of DNA; crime scene issues; introduction to the forensic DNA laboratory; assuring quality in DNA testing; understanding a forensic DNA laboratory report and DNA databases.

Session two of the two-part workshop will cover topics including pretrial DNA evidence issues; procedural considerations for the defense and prosecutor; trial presentation; jury issues; and expert witnesses.

DNA, Court, Attorney

W10 SWGIT Presents: Guidelines for Acquiring, Processing, Analyzing, and Archiving Video and Image Data

Richard W. Vorder Bruegge, PhD, FBI, OTD-FAVIAU/ERF, Building 27958A, Pod E, Quantico, VA 22135; Carl R. Kriigel, BS*, United States Army Criminal Investigation Laboratory, 4930 North 31st Street, Forest Park, GA 30297; William R. Oliver, MD*, Georgia Bureau of Investigation, NW Regional Crime Laboratory, Georgia Bureau of Investigation, 533 Underwood Drive, Trion, GA 30753; Herbert L. Blitzer, MBA*, Institute for Forensic Imaging, 338 South Arlington Avenue, Suite 111, Indianapolis, IN 46219; Melody A. Buba, BS*, FBI, OTD-DES-FAVIAU, Building 27958A, Pod E, Quantico, VA 22135; ; Marla E. Carroll, BS*, 6919 West Broward Boulevard, Suite #222, Plantation, FL 33317; and Mark J. Shuman, MD*, Miami-Dade County Medical Examiner's Department, Number One on Bob Hope Road, Miami, FL 33136*

After attending this presentation, attendees will have a better understanding of how to incorporate proper procedures for handling image and video evidence into their law enforcement activities. They will know what sort of equipment and software they should utilize, how best to document their procedures, and will also know something about the legal basis for the presentation of multimedia evidence in court.

This presentation will impact the forensic community and/or humanity by increasing the level of awareness within the community regarding multimedia evidence and the proper procedures associated with it. A better educated community will be able to more effectively utilize this type of evidence and ensure that the criminal justice system benefits to the greatest extent possible from it.

Images and video are intrinsic to law enforcement activities today. Crime scenes, suspects, and evidence are photographed to document steps in an investigation. Surveillance images are seized and processed in order to reconstruct events and help criminals. Some images, such as latent print photographs, are processed and then analyzed to identify suspects. Many of these images ultimately find their way into the courtroom for use at trial. Analyses conducted on these images are frequently crucial to the successful completion of an investigation.

The increased use of digital imaging technology in law enforcement has led many defense attorneys to raise multiple criticisms of it and law enforcement's procedures, in an attempt to exclude such evidence. In this environment, it is more critical than ever that law enforcement take active measures to ensure that its images and imaging procedures can be defended in the court room. Recognizing this challenge, the FBI formed the Scientific Working Group on Imaging Technology (SWGIT) in 1997 to address the myriad of issues that can arise related to the science and technology of imaging. As of July 2006, SWGIT had formally published over a dozen documents (with more in press) that address issues ranging from general guidance on chain of custody and the proper media for the preservation of image evidence, to procedures for image processing, the handling of video evidence, and advice on training in imaging. The purpose of this workshop is to acquaint law enforcement personnel with these documents and the guidance contained therein, so that the attendees can incorporate these guidelines into the procedures within their own agencies and laboratories.

Attendees will learn about chain of custody issues as they relate to crime scene photographs and surveillance video recordings from both analog and digital systems. They will also receive guidance regarding proper procedures for preserving such data and ensuring its integrity, as well as learn where they can go to find out more about it.

After a general overview, attendees will then be given some guidance regarding how to best utilize digital and traditional film systems for the acquisition of evidentiary photographs at crime scenes and in the laboratory. The selection of cameras and the steps necessary to acquire images sufficient for the purpose needed will be discussed. Included in the workshop will be a detailed explanation of image resolution and other factors that should be considered to determine which camera (and imaging system) is best suited for the purpose at hand. (It may surprise some to learn that digital imaging is not the answer to all of law enforcement's imaging needs!)

Attendees will also learn about closed-circuit television (CCTV) surveillance systems, including digital video recorders (DVRs). The proper means of recovering video evidence from DVRs will be discussed. Among the most important lessons of this part of the workshop will be to alert the student to the fact that recovering video evidence from such devices frequently involves procedures that are different from those usually applied in most other types of computer forensics examinations. The workshop will then address proper procedures for the capture and processing of video evidence by properly training personnel within a laboratory environment.

Once images and videos have been acquired in an investigation, they must be processed and analyzed to produce results meaningful to an investigation. SWGIT has developed guidelines regarding what sort of processing steps are most useful in a forensic setting and has also provided guidance on how to document those steps. Likewise, SWGIT has developed guidelines to provide imaging scientists with a set of "Best Practices," to ensure that the testimony offered by imaging experts is supported by practices as rigorous as those applied in other forensic disciplines.

Included in such best practices are those to ensure the integrity of the evidence, as well as to preserve it for long-term storage and retrieval. Workshop attendees will learn about the options available to them for ensuring such integrity and preserving their data over the long run.

Towards the end of the workshop attendees will learn about the recognition by ASCLD/LAB of the "Digital and Multimedia Evidence" discipline, which includes both Video Analysis and Image Analysis as subdisciplines. SWGIT recognizes that some confusion remains over what parts of a laboratory might be subject to accreditation under this discipline, and can provide guidance on this issue.

Finally, many in law enforcement remain concerned regarding the admissibility of digital images within the courtroom. This workshop will provide attendees with a reference list of case law, as well as common sense approaches to this issue, that should help them ensure that their images, no matter their source, are admitted in court.

Imaging, Photography, Video

W11 Restorative Dentistry as Evidence: Survival of Dental Materials in Extreme Conditions and Analytical Methods of Detection

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After attending this presentation, attendees will gain an understanding of the circumstances of incineration and cremation and the possible approaches for retrieval of evidence for the forensic odontologist. Emphasis will be placed on incinerated and cremated remains and the evidence that can be obtained from extreme situations. Participants will learn of the unique compositions of dental materials and how this knowledge can be applied in forensic odontology. They will learn how these materials present after incineration, how to detect them and use them as a source of identification for victims of incineration. The use of analytical instrumentation in analysis of dental materials will be presented. Participants will appreciate the increasing need for detailed dental record keeping.

This presentation will impact the forensic community and/or humanity by providing means to identify individuals when very few clues remain. Modern dental materials can have unique compositions. Knowledge of these compositions and detection of their presence in the dentition of victims can add another level of certainty to victim identification. In cases of incineration and cremation, analysis of non-biological materials may represent a last resort in confirming identity of a victim, as the physical relationships of the dentition may be destroyed in these circumstances.

Upon completion of this workshop, participants will gain an understanding of the circumstances of incineration and cremation and the possible approaches for retrieval of evidence for the forensic odontologist. Emphasis will be placed on incinerated and cremated remains and the evidence that can be obtained from extreme situations. Participants will learn how dental materials present after incineration, how to detect them and use them as a source of identification for victims of incineration. The use of analytical instrumentation in analysis of dental materials will be presented. Participants will appreciate the increasing need for detailed dental record keeping.

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A case report will be presented in which analysis of restorative materials helped to resolve the case. This murder case involved almost complete incineration of the victim.

Information will be provided about incineration conditions ranging from house fires to commercial cremation. The changes that take place in bone and teeth will be presented, and morgue and field recovery techniques for evidence will be discussed. Radiographic changes to the dentition will also be shown and discussed.

Cases involving incineration represent one of the most challenging situations for the forensic investigator. The dentition is one of the most resilient structures in the human body and can remain relatively intact when

exposed to high temperatures. This is due to the protection of the structures of the oral cavity. However, if the fire is extreme, the teeth will also be destroyed. Under this extreme, it is the non-biological artifacts that will be found. When all that remains are charred bone and tooth fragments, any non-biological evidence can be of great importance. The mouth is an excellent source for non-biological artifacts. Not only are crowns, and partial frameworks recoverable, but also restorative materials.

Quite possibly the largest hindrance to taking advantage of analytical instrumentation is a lack of awareness of what is available and the information that can be provided. The participants will gain an appreciation what information various analytical techniques can provide. This includes Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), X-ray Fluorescence (XRF), and Auger Spectroscopy. Technique selection, use of the machine, sample selection, and preparation will be discussed.

Numerous examples of dental materials analysis will be presented. Materials such as resins, endodontic sealers, posts, crowns, temporary filling materials, and prosthodontic appliances will be surveyed with respect to persistence after exposure to high temperatures. The physical and chemical changes of such materials when subjected to high temperatures will be presented. For example, resin and amalgam can change drastically in visual appearance and can easily be missed. For evidence retrieval, grid placement followed by archeological sieving and sifting techniques may need to be utilized. It is important to realize that these materials can resist the high temperatures and can be recovered. Participants will appreciate how elemental analysis can readily distinguish suspected evidence, both in the field and laboratory.

Finally, the role of the forensic odontologist as educator and proponent of accurate record keeping will be emphasized. The increasing complexity of dental materials and their potential for forensic identification underlines the importance of written descriptions of materials and procedures in the dental chart.

Restorative Materials, Incineration, Analysis

W12 Quality Assurance in Human Identification

Vincent J. Sava, MA, Andrew J. Tyrrell, PhD*, and Thomas D. Holland, PhD*, JPAC Central Identification Laboratory, 310 Worcester Avenue, Building 45, Hickam AFB, HI 96853*

After attending this presentation, attendees should be able to understand the basic quality assurance principles and measures applicable to human identification. Participants will learn the unique challenges faced by professionals involved in human identification when striving to have their facilities, procedures, and casework meet the standards demanded by the criminal justice system. Attendees should be able to utilize the material presented to formulate a quality assurance program for their organization.

This presentation will impact the forensic community and/or humanity by demonstrating how quality assurance in forensic laboratories and forensic programs has become a growing trend over the past decade. Formal quality assurance programs lead to objective and measurable standards and performance that ultimately strengthen and elevate the forensic science profession as a whole.

This workshop was formerly presented as Quality Assurance in Forensic Anthropology but has been expanded to include other professions involved in human identification.

Quality assurance programs in forensic laboratories and activities have been a growing trend over the past decade. Since 1999 the Joint POW/MIA Accounting Command, Central Identification Laboratory (JPAC-CIL) has implemented a stringent quality assurance program to ensure the scientific integrity of its casework. The CIL's quality assurance program ultimately led to the Laboratory's accreditation by the American

Society of Crime Laboratory Directors Laboratory Accreditation Board (ASCLD-LAB) in 2003--the first forensic skeletal identification laboratory to be so credentialed.

The goal of this workshop is to introduce the attendee to the CIL's Quality Assurance Program and to convey the lessons learned resulting from its implementation and growth. A video overview of the JPAC CIL is presented followed by an overview of its quality assurance program. In the latter, the concept of the scientific integrity of the laboratory is discussed followed by a summary of the "Surety" model of quality assurance.

The participants will become familiar with each measure that comprises the surety model of quality assurance. The importance of integrating and synchronizing all of the surety measures discussed during the workshop will be continually stressed. In Part I, infrastructure and support considerations necessary for a successful quality assurance program are also presented. Surety measures addressed include:

- Desired qualities of a laboratory manual and other vital documentation
- Adequacy and safety of facilities
- Policies and procedures conducive to a positive work environment
- Evidence management and security
- Training and professional development

Gathering and interpreting evidence is the focus of Part II where quality assurance in field operations and trace evidence analysis is discussed. The surety measures directly related to casework?the peer review process, validation of technical procedures, case file management, analytical notes, and documentation?are presented for consideration.

Quality assurance procedures and programs are ineffective in the absence of monitoring, enforcement, and corrective action. These are accomplished through a myriad of surety measures including proficiency testing, review of court testimony, audits, annual reports, and corrective action policies, which are presented in Part III.

In closing, the attendees will become acquainted with the problems that hindered, and the processes that led to, the accreditation of the JPAC CIL. In closing, surety assistance programs offered by the CIL will be discussed in the event an attendee's organization desires assistance with their surety programs or accreditation efforts.

Quality Assurance, Human Identification, Accreditation

W13 Scientific Research: A Guide to Designing, Conducting, Writing, Presenting, Publishing, and Analyzing Scientific Research

Amy C. Gruszecki, MSFS, DO, Southwestern Institute of Forensic Sciences, 5230 Medical Center Drive, Dallas, TX 75238; Gregory G. Davis, MD, MSPH*, Jefferson County Coroner ME office, 1515 6th Avenue South, Suite 611, Birmingham, AL 35233; and J. Keith Pinckard, MD, PhD*, Southwestern Institute of Forensic Sciences, 5230 Medical Center Drive, Dallas, TX 75235*

After attending this presentation, attendees will be able to (1) design a scientific study, including hypothesis formation and control group selection; (2) be familiar with the roles of HIPAA and an IRB; (3) be aware of funding resources for forensic research; (4) define standards for authorship on a research project; (5) understand the basics of how to write a scientific paper; (6) understand the publication process, including peer review and editing; and (7) analyze and interpret scientific literature already published.

This presentation will impact the forensic community and/or humanity by demonstrating Evidence collected at a crime scene or during a forensic autopsy has important implications for both victims and suspects. Medicine, in general, and forensic science, in particular, is coming under increasingly intense scrutiny and pressure to produce scientific research supporting its conclusions (i.e., *Daubert v. Merrell Dow Pharmaceuticals*

Inc. (1993)). This workshop is designed to discuss the elements needed to design and perform a valid scientific study and the steps needed to write and publish that study through a peer review process. It also is designed to teach a forensic scientist how to analyze a research study that has already been published, as not all published studies have scientifically valid conclusions. (Thus, scientifically invalid literature may have gone unchallenged in the scientific community and perhaps even in the courtroom.) This workshop is intended to increase the participant's understanding of research and thereby to improve the quality of forensic science literature published in the *Journal of Forensic Sciences*, *The American Journal of Forensic Medicine and Pathology* and other journals which represent our field.

Increasingly, medicine and forensic science must rely on the 'evidence based' scientific approach. No longer can assertions be made without valid scientific research to support those conclusions. Our judicial system relies on forensic science to provide sound science based on properly conducted research as a basis for the adjudication of suspected criminals. A scientist must also possess the skill to critically review published literature and come to one's own conclusions. The importance of sound research and critical reading is vital, as people's lives can be forever altered by poorly performed or improperly interpreted research.

This workshop is designed to teach the novice forensic scientist (or serve as a review for the experienced forensic scientist) about scientific research and literature. The workshop will consist of didactic presentations in four major areas. In the first section the development of a research study will be presented. During this section the development of a hypothesis and the importance of appropriate control groups and sample sizes will be discussed. The role of institutional review boards and the effect of the Health Insurance Portability and Accountability Act (HIPAA) will also be presented. The second section will address the importance of and suggestions for clear and concise scientific writing and tips for effective scientific presentations in a Power Point format. Hints for effective public speaking will also be reviewed. In the third section, the path of a paper through the publication process will be outlined. This section will include information on authorship responsibility, a journal's editorial and peer review process, and steps toward final publication, focusing on the *Journal of Forensic Sciences* and *The American Journal of Forensic Medicine and Pathology*. The fourth section will address the principles for critically reviewing a published manuscript to decide for oneself whether it should be considered appropriate and fundamentally valid in its design and conclusions.

By attending this workshop, participants will begin to appreciate the circular path of scientific research, writing, and reviewing. Understanding the principles of research design allows not only the performance of sound and valid research, but also the critical evaluation of published studies. Critical evaluation in turn reinforces the principles essential for scientifically testing an approach to solving problems encountered in the work of forensic science. The principles are applicable whether the problem being solved is related to a specific case on a specific day or to an unsolved issue in the field of forensic science.

Research, Scientific Publication, Forensic Science

W14 Doping: The World Anti-Doping Program and the Role of Medical Care Providers in Doping and Anti-Doping Efforts

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After attending this presentation, attendees will (1) understand how elite sport is organized across the World – under the umbrella of the International Olympic committee; (2) see the history of doping and the effects of doping on the athletes and on competition; (3) know the background and organization of harmonized efforts across the world to detect and deter doping by elite athletes in the Olympic and Paralympic Sports and how adverse analytical results are adjudicated; (4) see how doping controls are implemented and the roles physicians play in the doping control program; (5) understand the role of rogue physicians (and other providers) in aiding athletes to use performance enhancing methods or substances; and (6) understand the appropriate treatment of elite athletes by physicians and other medical care providers.

This presentation will impact the forensic community and/or humanity by making attendees aware of doping and the role that medical care provides can play in both the doping process and in doping control programs. This improved understanding of doping and doping control can impact positively the professional and public awareness of the problems of doping and how the ethics of sport and the loss of a "level playing field" are having a negative impact on sports in general. The ultimate effect is with the public, in general, having an improved awareness of the negative impact of doping and the need for doping control.

The intent of doping control is to "level" the competitive playing field, to protect the health of athletes, and to maintain the integrity of sport. A World Anti-Doping Agency has been established to coordinate world wide anti-doping efforts and to implement the World Anti-Doping code (Code). The Code was adopted at a World Conference on Doping held in Copenhagen, Denmark, March 3-5, 2003. The Code clarifies the definition of doping and establishes procedures to harmonize international efforts in sample collection process, testing laboratories accreditation, result reporting, and result adjudication. While the International Olympic Committee (IOC) is responsible for anti-doping activities at the Olympics, the International Federation (IF) of each sport is responsible for similar activities at their competitions and the IFs have adopted the World Anti-doping Code to harmonize their rules for anti-doping activities. The anti-doping rules are included in the rules of each sport, along with items defining the field of play, rules of competition, equipment, and other items necessary to ensure a fair competition. There are over 30 IOC-accredited laboratories throughout the world, which are held to a high level of quality to earn their accreditation, and handle the doping control tests for Olympic and Paralympic Sporting Events.

Efforts to enhance physical performance date back to the original Olympics in Greece and have become increasingly sophisticated and dependent on medical and pharmaceutical advances. This has created a situation where doping with advanced methods may well involve a number of persons to have knowledge and involvement in the process. All athletes continue to be held to the concept of "strict liability" which means the athlete is ultimately responsible for the presence of a prohibited substance in his or her body irrespective of where or how the substance entered the

body. In addition, athletes at the elite level must provide a blood or urine specimen when appropriately identified for testing and will be subject to penalty if a test is refused. In spite of the tight controls on athletes the control on coaches, trainers, physicians and other related persons is not as stringent. The World Anti-doping Code does allow for sanctions on persons that assist athletes in doping and provides a mechanism to control the activities of support personnel. Despite this, there is a need to reach medical care providers and other support personnel with the message concerning the impact of doping on sport and the need to treat all athletes in an ethical manner. Recent cases reported world wide have emphasized the fact that “rogue” medical care providers and athlete support personnel are willing to go to any length to enhance the performance of the associated athlete. This involvement of associated persons is very detrimental to sport.

World Anti-doping Agency, Physicians, Doping Control

W15 DNA 101: Understanding DNA Evidence for the Non-Scientist

Carll Ladd, PhD, Connecticut Forensic Lab, 278 Colony Street, Meriden,, CT 06451; Greg K. Hampikian, PhD*, Boise State University, Biology Department, Boise State University, 1910 University Drive, Boise, ID 83725-1515; and Eric J. Carita, MS*, Connecticut Forensic Laboratory, 278 Colony Street, Meriden, CT 06451*

After attending this presentation, attendees should be able to understand an electropherogram (a DNA profile), be familiar with basic DNA statistics such as the “random match probability,” and be able to read and understand a typical forensic lab report.

DNA evidence is being presented in courtrooms across America, and has become one of the basic tools of human identification. Unfortunately, although the use of DNA in criminal investigations has become routine, its interpretation is still the purview of experts. Since this science is nearly omnipresent, everyone involved in the justice system should have a working knowledge of basic DNA science. This presentation will impact the forensic community and/or humanity by bringing the novice to that fundamental ability.

DNA profiles have become part of mainstream American culture, found daily in newspapers and television shows across the country. While the discussion of DNA evidence is everywhere, a basic understanding of its interpretation is still fairly uncommon. This course is designed for the non-scientist who wants to understand how DNA evidence is collected, processed, and interpreted. It is taught by three experts in the field: Carll Ladd, DNA Supervisor of the Connecticut Forensic Laboratory; Greg Hampikian, Boise State University professor in Genetics and Criminal Justice Administration; and Eric Carita, a practicing DNA Criminalist at the Connecticut Forensics Lab. Each presenter is a forensic scientist and teacher with both laboratory and courtroom experience. Topics covered include forensic sources of DNA, sorting sperm from vaginal DNA, amplification from invisible traces, reading a lab report, understanding a DNA profile (electropherogram), Short Tandem Repeats (STRs), mitochondrial DNA, Y-STRs, basic DNA statistics, and the use of non-human DNA in actual casework. This four hour course takes the beginner from all the way from basic DNA biology to reading actual case reports. No prior experience or knowledge of DNA is needed.

DNA, STR, Mitochondria

W16 Investigating SSRI Related Deaths: Are the Drugs Really to Blame or Is This a Matter of Science Versus the Law?

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After attending this presentation, attendees will have a better understanding of the diagnosis process that leads to the prescription of SSRIs; learn more about the pharmacological aspects of SSRIs; learn about present day clinical trials regarding SSRI drugs; understand suicidology as it may relate to the usage of the drugs; learn how a couple of the cases have been investigated and the instrument used to interview significant witnesses; and, become acquainted with the legal practices and cases that have been brought before our judicial system where opposing views will be presented.

This presentation will impact the forensic community and/or humanity by increasing their knowledge and awareness of how SSRIs are used and the possible implications they may have on human behavior. Furthermore, armed with the information from this workshop, they will be able to conduct death investigations that are more thorough and will provide society with a better understanding as why these situations may have occurred.

- In July 1997 in Kansas City, MO a 13-year-old boy committed suicide by hanging himself from the door in his closet.
- In February of 1998, in Cheyenne, WY a 60-year-old man shot and killed his wife, his daughter, and granddaughter before turning the gun on himself.
- In November 2001, near Charleston, SC a 12-year-old boy murdered his grandmother and grandfather. He was subsequently convicted for the murders.
- In May 2002, in Dallas, TX, a 62-year-old man shot and killed himself.

A common thread throughout these cases is that all four subjects who committed these violent acts had recently been prescribed an SSRI and were in the very early stages of using the drug for the first time. Is this a coincidence or are the drugs to blame? What about the science and the law, do they agree? Where do we go from here and how do we investigate these cases so as to protect and serve society and the general public health?

Over the years SSRI's have been described as being a wonder drug for the treatment of anxiety and depression. However, others have proposed that there is a direct linkage between the immediate affects of the SSRI's that have caused some users to commit murder and/or suicide as described above.

With that premise in mind, the purpose of this workshop is to present a multidisciplinary panel where many perspectives of the issue will be discussed. The session will start with Forensic Psychiatrist Dr. Michael Welner who will provide an understanding of the diagnosis process that leads to the prescription of an SSRI and why they have served the psychiatric community so well. Following his presentation the attendees will learn about the pharmacological make-up of SSRI's. Then, Ron Maris, PhD, a Suicidologist, will discuss some of the aspects of the suicidal act as it may relate to the usage of the drugs and will address the results of certain clinical trials.

Dr. Maris and attorney Andy Vickery also designed an interview instrument to be utilized during the course of interviewing significant witnesses related to SSRI related death cases. It is intended to provide the necessary information that will help to understand the dynamics involved and to ensure all the appropriate information has been gathered for the formation of an accurate opinion. In the investigation of such cases, James Adcock PhD will discuss the investigative processes and the issues surrounding the utilization of Maris' interview instrument. Ultimately, from opposing attorneys (Mr. Andy See and Mr. Andy Vickery), the audience will become acquainted with the legal practices, cases and decisions that have been rendered in both civil and criminal trials regarding SSRI litigation.

SSRI Deaths, Investigation, Manner of Death

W17 Analysis of Vegetable and Animal Oil Residues From Fire Debris Samples

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Douglas E. Byron, BS, Forensic & Scientific Testing, Inc., 3069 Amwiler Road, Suite 9, Atlanta, GA 30360; and Douglas J. Carpenter, MS*, Combustion Science & Engineer, 8940 Old Annapolis Road, Suite L, Columbia, MD 21045*

After attending this presentation, attendees will have a clear understanding of what vegetable and animal oils are, how they may cause a fire, and how to analyze their residues at the forensic laboratory.

After this workshop, the participants will be able to return to their forensic laboratories and set up the proper method of analysis of vegetable and animal oil residues in order to assist the fire investigators. More importantly, they will know how to interpret the results of such analyses and how to express the limitations of the findings.

This presentation will impact the forensic community and/or humanity by allowing forensic scientists to provide a new service to the fire investigation community, which can only benefit the outcome of fire and arson investigations. This will contribute to the improvement of the services offered by crime laboratories. This workshop will also provide a new level of knowledge to forensic scientists, which will result in a better grasp of how a crime laboratory can assist a fire investigator and will, hopefully, improve the development of future research and advance the present science.

Participants will learn the chemical and physical properties of vegetable (and animal) oils and how they can cause a fire. Then, the different sources of vegetable oils will be introduced, which enable participants to recognize the wide availability of such oils.

The principles of the phenomena of self-heating and spontaneous ignition will be explained thoroughly, and aspects of the laboratory testing and practical examples will be presented. The forensic approach to the analysis of vegetable oil residues, the limitations of such analysis, and its integration in the fire investigation will also be described to participants.

The examination of the samples will be clearly depicted. Participants will learn about the extraction of vegetable oil residues, their preparation, and finally, their analysis. An in-depth description of the interpretation of the resulting chromatograms will be presented. A short primer on biodiesel, a prominent alternate fuel, will also be offered. The workshop will conclude with small-group practical exercises conducted under the close supervision of the presenters.

Fire Debris Analysis, Vegetable and Animal Oil Residues, Interpretation of Chromatograms

W18 Missing Persons: Resources, Techniques, and Identification

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Throughout the workshop, case examples will demonstrate model working relations between the various forensic agencies and laboratories already in operation. After attending this presentation, attendees will have a clearer mutual understanding of various functions and responsibilities will improve sample processing and lead to an increase in identifications.

This presentation will impact the forensic community and/or humanity by better informing attendees about the resources available for missing person cases and how practitioners are processing cases. They will gain insight into the many entities that are involved with missing person investigations. Participants will learn how they may better assist families of a missing person, law enforcement officials, forensic anthropologists, odontologists, DNA examiners, Medical Examiner/Coroners, and others that serve in identifying the missing.

Recent initiatives by the Department of Justice as well as state and local legislations have focused attention on the large number of unresolved missing person cases throughout the United States. There are hundreds of unidentified human remains that reside in Law Enforcement agencies, Anthropology Laboratories, and Medical Examiner/Coroner's offices. Most unidentified human remains cases are cold cases that receive minimal attention. These remains still have the potential to be identified, repatriated, and lead to homicide convictions.

Upon the completion of this workshop, participants will be better informed about the resources available for missing person cases and how practitioners are processing cases. They will gain insight into the many entities that are involved with missing person investigations. Participants will learn how they may better assist families of a missing person, law enforcement officials, forensic anthropologists, odontologists, DNA examiners, Medical Examiner/Coroners, and others that serve in identifying the missing. Many Law Enforcement and Medical Examiner/Coroner offices that store the remains do not have the resources or knowledge of services that are available to them at no charge. This workshop will make the resources known to all who are involved with missing person cases. The other part of the missing person equation is who is missing and what is needed for identification. Information about the individuals that are missing must be supplied to those who work with unidentified human remains. Biological relatives of missing persons need to know who to go to, what information is important, and what samples are needed to assist in identifying their missing relatives.

The workshop will be presented from the perspective of a missing person investigation. This includes presentations from:

- Investigators describing missing person cases, interactions with the families, techniques used in the investigation, and how missing person cases can be cold case homicides.
- State Missing Person Clearinghouses who interface between families and medical-legal authorities will present their programs and roll in the investigation.

- Anthropologists and Odontologists will present what types of cases are seen and the methods used to find, recover and examine unidentified human remains.
- Forensic DNA Examiners will present what types of samples are seen, how the samples are processed, and why DNA profiles are entered into the Combined DNA Index System (CODIS). Statistical analysis of DNA matches will be discussed and how this should be presented and explained to law enforcement and/or Coroner/Medical Examiners.
- Medical Examiner/Coroners will present how cases are processed and what avenues are available to them for difficult cases.
- Legislative and Victim Advocates will present their role in this initiative including model legislation for missing person and the California Department of Justice's success in facilitating a state wide missing person program.

Throughout the workshop, case examples will demonstrate model working relations between the various forensic agencies and laboratories already in operation. Clearer mutual understanding of various functions and responsibilities will improve sample processing and lead to an increase in identifications.

Missing Persons, Unidentified Human Remains, DNA

W19 Management Issues in Forensic Document Units

Diane K. Tolliver, MPA, Indiana State Police, Indianapolis Regional Laboratory, 8500 East 21st Street, Indianapolis, IN 46219; and Thomas P. Riley, BS*, Michigan State Police, Lansing Forensic Laboratory, 7320 North Canal Road, Lansing, Michigan 48913*

After attending this presentation, attendees will have learned possible solutions to frequently encountered issues related to managing a forensic document unit.

This presentation will impact the forensic community and/or humanity by making forensic document units operate at a higher level of efficiency while maintaining the highest level of quality.

Issues relating to forensic document units continue to present daily challenges to those within and those supervising these units. This workshop will focus on many of those daily issues. Workshop participants will be encouraged to present approaches they have utilized that have failed AND those which have succeeded. The instructors, Diane Tolliver and Tom Riley, both have experience as forensic document examiner trainees, forensic document examiners working at the bench level, and now as supervisors of forensic document units. Their presentation will engage participants in discussion regarding the questions, scenarios, and potential solutions, drawing upon the collective experience and wisdom of course participants.

Questions will be discussed such as what impact a heavy backlog has on the quality of work product produced by the forensic document examiner. How does a supervisor of forensic document examiners insure that a quality work product is being maintained? Are requests for document examinations changing the operation of a forensic document unit? In some labs, there seems to be a decline for this type of service; in other labs, it has never been greater. Why? What role does a lack of adequately trained personnel have on case backlogs?

What part does laboratory accreditation play in the turn-around time of working a questioned document case? Should the laboratory foot the bill for an examiner to become and stay certified? How necessary is it for a forensic document to become certified today? Why is employee retention an issue for some and not for others?

These situations and more will be presented to the workshop attendees with one or more possible answers. Alternate solutions and tried and failed approaches will be solicited from attendees.

This workshop will be of interest to supervisors, administrators, and forensic document examiners in laboratories that provide forensic document examination services. These human resources and those components of the criminal justice community, including the customer, could be impacted as a result of this workshop. It is expected that the workshop participant will come away with a sense of support with how they deal with management issues and/or fresh ideas to try in solving them.

Management, Document, Issues

W20 Forensic Image and Video Processing

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After attending this presentation, attendees will know what the possibilities are with digital images and video streams, and which techniques can be used in forensic science; will learn how quality assurance principles are applied to digital evidence; and understand how validation of methods are important in this workshop.

This presentation will impact the forensic community and/or humanity by demonstrating how visualization in court, measurements in images and error estimations, and image processing techniques that can be used, and a link to digital evidence.

During this workshop information will be provided on new developments of forensic investigation of (digital) images and video streams and the use of 3-dimensional computer modeling in forensic investigations.

Traditional sources of images as evidence concern crime scene photography, and more specifically, photographs of fingerprints, tool marks, shoe prints, and other impressions. A short overview of image processing techniques is given. Special attention is given to the introduction of artifacts by image processing (e.g. FFT on fingerprints), imaging in pathology and quality assurance aspects.

During the last 30 years the use of CCTV-camera systems has become widespread. Typical questions concern the quality and the selection of images from a specific camera in a multi-camera-recording. Digital processing of video streams for presentation and storage purposes, and the compression techniques that are applied in digital CCTV-systems, lead to questions about the integrity and authenticity of recordings. Also questions about image interpretation like facial recognition, body length, or car speed, often in low resolution, time lapse, or compressed images have increased.

New sources of video streams and images are video recordings from handy cams, digital photo camera's, internet, and cellular phones. Typical questions about these recordings concern the integrity and authenticity of the recordings, the data compression techniques used, the synchronicity of sound and images, compensation for camera movement, and the conversion of a video stream to a higher resolution image.

We will focus on methods for digital capture and analysis of analogue and digital multiplex surveillance recordings, state-of-the-art image enhancement techniques as contrast stretching and de-blurring, as well as new methods as super resolution, stabilizing and automatic tracking.

Since more images are being processed for forensic investigation, new methods have been developed for answering questions about the interpretation of images. Examples given: Is it possible to read a license

plate number? Is our suspect, or his car, the one depicted in the image? What is the body length of the robber or the speed of a car? Is it possible to do a reconstruction of an accident or a shooting incident from the information in these images? Methods for image comparison, facial comparison with non standardized images, image reconstruction, and Photogrammetry are presented and discussed. Special attention is given to accuracy of the results and the impact on the conclusions from these investigations. Furthermore, there will be hands on training during this workshop.

Finally, some extra attention is given to the use of 3-dimensional computer modeling in forensic investigations, since we believe that these techniques will have an impact on traditional crime scene photography.

Computer models and animations have been recently used for analyzing video by superimposition of computer generated views of the model on the video images, for the visualization of complex scenarios in animations and for testing scenarios against video footage and evidence in crime scene photographs. Examples: the reconstruction of car accidents from photographs, analysis of blood spatter patterns from photographs using a computer model of the crime scene, the visualization of wound channels in computer models of human bodies, the reconstruction of bullet trajectories, the reconstruction of a burglary using the limited information in dark images from a multi camera video recording, and the analysis of firework explosions from video recordings, photographs and geographical data. Special attention is given to modeling techniques, the accuracy of the models, methods for visualizing uncertainties and possibly erroneous suggestions coming from these visualizations.

The use of image processing in the analysis of patterned injury of the skin, with emphasis on child abuse and as an aid in image analysis in forensic pathology will be discussed. The interpretation and recognition of image processing artifacts and image quality issues in forensic pathologic evaluation will be demonstrated.

Image Analysis, Biometrics, 3D

W21 Forensic Science: Moving Forward Through the Changing Tides

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After attending this presentation, attendees will understand how forensic science is advancing in the 21st century, including changes in technology and legal precedents in terms of how these changes will effect evidence collection, crime laboratory management and operation, testimony, funding, education, certification, standards and accreditation.

This presentation will impact the forensic community and/or humanity by providing forensic scientists with insight into developing and

future forensic technologies and new legal precedents and point out how these technologies and legal precedents will cause changes in the facilities where they work, as well as, the way they work. Additionally, presentations will help forensic scientists prepare for changes in their relationships with those that they support, including field investigators, the courts, and the public at large, which will also be required because of changes in technology and legal precedents.

The changes in technology and legal precedents will effect evidence collection, crime laboratory management and operations, testimony, funding, education, certification, standards and accreditation. Current Federal funding is heavily earmarked primarily for DNA activities, crime laboratories and medical examiner facilities yet other disciplines have a myriad of needs which need to be addressed.

As technology advances it will be critical to develop tools to dispense the knowledge of change; to project changes in evidence collection and processing; to demonstrate how such changes will impact court testimony; the impact of lab accreditation towards credibility; to predict new forensic disciplines; the importance of recognized certification in this era of forensic specialization; and why ethical behavior is scrutinized by the public. TV shows, movies and books have given rise to certain realization and expectations among the general population who serve on juries. Individuals have begun to expect to hear about scientific evidence because they learned about it through the media, even if such evidence is not appropriate. The implications of this pressure, known as the CSI Effect, will be discussed

Forensic Advancements, Technology, Future of Forensics

W22 Personalized Medicine and Pharmacogenomics for Addiction and Pain Management — Implications for Forensic Pathologists and Toxicologists

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After attending this presentation, attendees will be able to recognize the role of drug therapy and other therapy for addiction and pain; understand the potential for pharmacogenomics and personalized medicine to increase safety and efficacy in the treatment of addiction and pain; and realize through clinical and forensic case presentations the roles of the plasma/blood concentration, drug-drug interactions and the possible role of pharmacogenomics for the interpretation of drug toxicity in pain management and addiction cases.

In many areas of the United States accidental overdose deaths related to addiction and pain management have been on a sharp increase in recent years. The reasons for this are many and complicated and some cases are not easily solved with traditional toxicology and pathology exams. With the emergence of genomic medicine, the genetic contribution to drug toxicity may be helpful to interpret drug related toxicities and drug-drug interaction in forensic toxicology and pathology. An update on current therapies for pain and drug addiction and an introduction to pharmacogenomics and personalized medicine will impact the forensic community and/or humanity by leading to a better understanding of this trend in accidental drug overdoses.

The workshop will begin with an introduction covering the epidemiology of accidental drug overdoses and the sharp increase in such deaths seen in the last few years. To illustrate the potential for drug-drug

interactions and the oftentimes multi-drug approach to modern pharmacotherapy, an update on the management and monitoring of pain and addiction will be covered. An introduction to pharmacogenomics and personalized medicine will show how these two, fairly new specialties may be used to help interpret the oftentimes-complicated death investigation findings typical of accidental drug overdoses. Clinical and Postmortem case studies will illustrate the applications and limitations of this multi-disciplinary approach to investigating drug toxicity.

Addiction and Pain Management, Pharmacogenomics and Personalized Medicine, Accidental Drug Overdose

W23 The Role of Atmosphere in Forensic Investigation: A Closer Look at the Environment in Forensic Science

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The goal of this presentation is to enhance awareness of the impact of weather on biological organisms which may be utilized in legal investigations; making forensic scientists aware of the scope and applications of forensic climatology; and discussing the influences of weather on forensic taphonomy and human decomposition.

Forensic climatology is inextricably linked to civil and criminal forensic investigations. This presentation will impact the forensic community and/or humanity by making forensic scientists aware of its possible impact on their casework.

Insects are the most abundant organisms on Earth, and they are closely associated with humans and human activities. As the human population increases and human habitation and activities expand, we are in closer contact with insects and related invertebrates than ever before in the human history. The process of decomposition is also directly linked to the activities of insects and their cohorts. The practicing forensic scientist, pathologist, or death investigator must understand that insect biology is controlled by environmental factors, particularly temperature and humidity, which are influenced by the microclimatic conditions of specific habitats and larger, regional zones of climatic change. As a result, these associations provide important forensic evidence. Forensic entomology is the application of entomological knowledge and experiences to litigation for justice in our society, in which the postmortem activities of insects and associated organisms associated with the human remains, are heavily depended on environmental conditions at the scene. As a result, the close approximation of postmortem environment is exceedingly important in forensic investigations. This workshop will discuss how climate affects insect life and how important the close approximation of postmortem environment at the scene is in forensic investigation. Satellite-based global climatological models being applied to produce a close approximation of the GPS-referenced postmortem environmental conditions at the scene will also be discussed.

Atmosphere, Entomology, Taphonomy

W24 Finding the Needle in the Haystack: Improving the Toxicological Investigation of Drug-Facilitated Sexual Assault and Other Crimes

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After attending this presentation, attendees will be able to recognize the challenges associated with investigations of drug-facilitated crimes; identify the common drugs used to facilitate these crimes, the pharmacological properties of these drugs, and analytical techniques to improve their detection in victim samples; develop an awareness of the successful prosecution of ethanol-facilitated sexual assault; and understand the means of overcoming the challenges of drug-facilitated crimes.

This presentation will impact the forensic community and/or humanity by improving the field's capabilities in investigating drug-facilitated crimes.

Allegations of drug-facilitated crimes, particularly drug-facilitated sexual assault (DFSA), have increased significantly in the past decade. Unfortunately, because of the numerous challenges of these cases, toxicologists assigned these cases are oftentimes looking for "the needle in a haystack." However, there are steps that can be taken by toxicologists to improve detection of the most common drugs.

This workshop will address the current information on the drugs most often used to aid in the commission of a crime. After an overview of drug-facilitated crimes that focuses on the challenges faced in these investigations, there will be a discussion on successful prosecution of ethanol-facilitated sexual assaults. This will be followed by a discussion of the pharmacology of the drugs commonly used to facilitate a crime and analytical methods to improve detection of these drugs. Case studies will also be provided to demonstrate the vast number of drugs used to commit drug-facilitated crimes. The workshop will conclude with suggestions to overcome the challenges of DFSA and recommendations for the management of these cases. Use of these recommendations can help the attendee better the chances of successful resolution of drug-facilitated cases.

Drug-Facilitated Crimes, Ethanol-Facilitated Sexual Assault, Pharmacology



B1 The Potential Recoverability of Data From Hard Drives of Computers From Fire Scenes

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After attending this presentation, attendees will understand the potential for recovery of data from computers recovered from fire scenes.

This presentation will impact the forensic community and/or humanity by demonstrating how computers that have been subjected to fire are often disregarded as potential evidential sources and the situations in which hard drive data can be recovered from computers that have been within full compartment fires.

With the ubiquitous nature of computers in modern society it is common to find these types of items during the investigation of a fire scene. One question which has arisen is whether or not it is possible to recover information from hard disc drives which have been damaged within a fire and secondly what parameters (exposure to heat, protection afforded by the computer case etc) define this recoverability.

A hard disk drive is a complex system: The disk pattern consists of a number of rotating platters with a ferro-magnetic coating. An electro-mechanical arm carries a number of read/write heads, which may be moved so that the heads (carried on the end of the arm) may be positioned over any spot on the disk. The arm and heads are controlled by the drive's interface electronics (usually mounted on a PCB which is an integral part of the drive). A hermetically sealed case surrounds the disk pattern. Provision is made for attaching the interface electronics to the host computer via a set of multipole connectors.

Data is only irrevocably lost from such a disk by the (usually deliberate) alteration of the magnetic pattern on the disk (logical destruction) or by the corruption of the disk's magnetic coating (physical destruction). Destruction (by fire or other means) of the electronics, connectors, or even the arm/head mechanism may leave the magnetic surface and hence the data unharmed.

It has been assumed that the recovery of evidence such as hard drive data (both pictures and documents) has not been possible once the computer housing the hard drive has been exposed to fire conditions. A preliminary study was undertaken to test this hypothesis. A number of computers containing hard drives with stored documentary files were placed into a fully furnished compartment which was set on fire. The compartment fire was allowed to develop until flashover or near flashover was achieved.

The drives were subject to three stages of analysis: firstly a preliminary visual inspection was made. Secondly the drives (where possible) were connected to a forensic data capture station for interface testing and retrieval of basic drive parameters. Finally the drives (where possible) were imaged and a search performed.

Visual inspection: The serial number and drive parameters were retrieved from any extant labels. The feasibility of connecting power and data cables to the drive (in the light of the degree of damage) was assessed. The general appearance of the drives was recorded.

Interface testing and parameter retrieval: If a drive was sufficiently intact to permit the connection of data and power cables, it was mounted in a test caddy and inserted into a digital forensics workstation. The functioning of the interface electronics, drive motors,

head mechanism was tested using the Hitachi Drive Function Test (DFT) program, and the results recorded.

Imaging and search: If a drive was found to be sufficiently functional, an attempt was made to recover partition information using *fdisk*. Where partition information was recovered, an image of the drive was taken using the *dd* utility. The image was mounted and searched using the *Autopsy* digital forensics toolkit. A simple ASCII search for a 12-byte string was made ("autoexec.bat" in the case of a Windows file system - none of the Apple drives were sufficiently undamaged to allow a search to be made) and the results of the search recorded. All tests used in this stage were based on the Helix V distribution of Linux.

It was possible to rapidly recover some data from the test disks without resorting to removal of disk patterns.

Data Retrieval, Computers, Fire Damaged

B2 Biological and Chemical Influences on a Canine's Ability to Differentiate Hand Odor Samples

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After attending this presentation, attendees will learn about the effects of biological and chemical influences from hand odor samples on alerts produced by human scent identification canines.

This presentation will impact the forensic community and/or humanity by providing a better understanding of the correlation between volatile organic compounds and the human and non-human compounds present in hand odor samples and canine alerts.

Human scent identification line-ups are frequently utilized in European countries such as the Belgium, Bulgaria, Denmark, Finland, France, Germany, Hungary, Lithuania, Netherlands, Poland, Russia, and Slovakia. They establish an association between a suspect and an object or location based on canines matching human scent collected from a crime scene to scent collected from the hands of a suspect. Scent identification line-ups are possible as persons have distinctive odors and canines are capable of discriminating between odors. Many theories have been put forward to explain the production of human odor as it is a complicated process which is not yet fully understood. The basis on which the dogs are producing an alert to human scent is also yet to be determined.

The human body produces odors made up of a variety of organic compounds such as fatty acids, alkanes, aldehydes, ketones and esters. Human scent has been defined as the volatile organic compounds which are present in the headspace of a scent sample. However, other substances may also contribute to human scent. Solid phase micro extraction gas chromatography mass spectrometry (SPME-GC/MS) is an analytical technique which has been used for the extraction of volatile organic compounds which are present in the headspace of various forensic samples such as drugs and explosives. SPME-GC/MS has been successfully used for the extraction, separation, and identification of the volatile organic compounds which are present in the headspace of scent samples.

The human skin can be described as a continuous source of “rafts” which are dead skin cells that are constantly shed from the stratum corneum of the epidermis. It is believed that bacterial action on these “rafts” in combination with genetic differences, diet, and glandular secretions of the skin greatly influences the odor that is produced by an individual. When an individual comes in contact with an object, “rafts” are deposited which makes it possible for a scent sample to be collected. Differences have been shown between individuals in the amount of “rafts” deposited on an item when it is touched. It has been observed that for individuals that have been in contact with objects for four minute time periods, human scent identification canines show greater difficulty in identifying certain individuals as compared to others.

This paper will discuss the influences of volatile organic compounds (VOC's) and human and non-human components of hand odor samples on the alerts produced by human scent identification canines. The identification and quantification of the volatile odor compounds present in the headspace of scent samples collected on pre-cleaned cotton absorbers were obtained using SPME-GC/MS. The absorber materials used in this study were pre-treated with a methanol-modified supercritical fluid extraction (SFE) method to achieve analytical cleanliness. The effects of temperature and light on stored hand odor samples have also been evaluated. Real time polymerase chain reaction (PCR) was used for the quantitative and qualitative analysis of the human and non-human components of hand odor samples collected on pre-cleaned stainless steel bars.

The present study demonstrates that using an optimized pre-cleaned sampling material and storage conditions it is possible to get reproducible inter- and intra-day VOC patterns for individuals and sufficient variation between individuals for differentiation. Observed VOC patterns are generally comprised of alcohols, aldehydes, ketones, and esters. Additional work is needed to determine the role of an individual's microbial flora but initial results demonstrate some variability in the identity and quantity of microbial populations which may contribute to the VOC patterns observed. The obtained results will be discussed in this paper.

Human Scent, SPME-GC/MS, VOC's

B3 The Quantification of Drug Residues and Drug Odorants Under Variable Conditions Evaluated by SPME-GC/MS and With Detection Canines

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This goal of this presentation is to describe ongoing research involving the quantification of signature odor chemicals of narcotics and the relative abundances of odorants based on the sample size, length of exposure and degree of containment.

This presentation will impact the forensic community and/or humanity by presenting the differences in odor recognition used by detector dogs to locate controlled substances under varying conditions.

Narcotic odor is a result of odorant(s), which is/are characteristic of a drug and detected by the olfactory receptors. Previous research has established that certified law enforcement detector canines often do not alert to the parent drug itself, rather they alert to by-products or decomposition products. These products have been shown to be volatile organic compounds (VOCs) used by detection canines to locate controlled substances. For example, research into the odorants of cocaine and MDMA has shown methyl benzoate and piperanol,

respectively to be responsible for detected odors by the majority of law enforcement canines tested. This present study focused on evaluating the relative abundance of the odorants emanating from specific narcotics under varying conditions. The study also examined differences in odor perception of canines based on sample size, degree of containment and length of exposure.

The methodology involved included headspace solid phase micro extraction (SPME) combined with gas chromatography/mass spectrometry. Headspace SPME sampling makes it possible to obtain consistent samples of VOCs above very small quantities of drugs as well as very large samples. Headspace sampling was carried out using variable sample sizes and variable containment scenarios ranging from completely closed to completely open. The SPME GC/MS method utilized a 70µm Stable Flex™ Carbowax Divinylbenzene (CW/DVB) SPME fiber (Supelco). This fiber has been previously determined, experimentally, to meet optimum standards for narcotic laboratory testing. Carbowax Divinylbenzene has proven effective in removing volatiles from the headspace of illicit drugs. This research includes the identification of the volatile headspace chemicals above a variety of drug samples. The potentially variable levels of these volatile organic compounds will be presented and examined.

The illicit drugs involved in this study included marijuana, cocaine, and heroin. The active odor signature chemical of cocaine has been confirmed to be methyl benzoate with threshold levels of 1-10 mg spiked methyl benzoate or 0.1-1 ng/sec-odor diffusion. The level of signature odor chemicals needed to initiate consistent alerts from law enforcement detector dogs further enhances the significance of dog alerts to possible controlled substances, because these levels are only present if significant contamination occurs. The specific amounts and the variable levels of the odor chemicals will be investigated to further justify this statement.

Current research has determined the highest composition of volatile organic chemicals present in the headspace of marijuana to include α -pinene, limonene, β -pinene, carene, and camphene. However based on the individual samples of marijuana analyzed, the relative concentration of α -pinene was seven times higher than the limonene with a ratio of 58:8. It was therefore necessary to determine the exact composition of this odor in addition to its relative abundances, based on sample size. Quantification of parent drug residues and drug odorants has also been evaluated for different paper currencies (U.S. and Jamaican).

The results demonstrate that the sampling time, sample size, containment vessel, and degree of containment can have an influence on the ratio of VOCs observed. The significance of these results to drug odor detection by law enforcement canines will be discussed. These studies have not shown drug odorants to be present above paper currency in general circulation supporting the theory that there is insufficient drug contamination on paper currency in circulation to initiate an alert by a properly trained law enforcement detector dog.

Odorants, Canine, Illicit Drugs

B4 Explosive Training Aid Variance Affecting Canine Detection

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The goal of this presentation is to present recent findings from an ongoing study aimed at determining how varying the quantities and presentation methods of high explosive and low explosive training aids can affect the detectability of said training aids by trained law enforcement detection canines. In addition, this study explores the potential for the use of smokeless powders and Controlled Odor Mimic Permeation Systems (COMPS) as training aid substitutes for high explosives detection.

This presentation will impact the forensic community and/or humanity by demonstrating how the detection of the majority of high explosives of interest can be accomplished using non hazardous training aids by the optimal selection of smokeless powder samples combined with selected COMPS developed.

This paper presents recent findings from an ongoing study aimed at determining how varying the quantities and presentation methods of high explosive and low explosive training aids can affect the detectability of said training aids by trained law enforcement detection canines. In addition, this study explores the potential for the use of smokeless powders and Controlled Odor Mimic Permeation Systems (COMPS) as training aid substitutes for high explosives detection.

The interest in odor detection is on par with the interest found for many other forensic related fields of study. It has become a focused area of research over the past number years because of its importance to the forensic, law enforcement, and legal communities. Despite the increasing number of instrumental methods for detection of these characteristic chemical odors, the use of trained canines as biological detectors remains one of the most widely accepted methods to reliably detect explosives, drugs, arson, cadavers, mold, and human scent. Therefore, detector-dog response is one of the major applications involved with odor detection studies, both for the determination of the chemical signature of individual odors to which these canines are actually alerting, and to whether or not there is a common element within different items to support the use of contraband mimics. However, disputes still exist about the methods of training and the compounds on which the dogs are trained. Some believe that consistency in the quantity of the training aid compound is important whereas others use varying amounts for training purposes. This study addresses some of these issues.

Previous research has shown that trained law enforcement detection canines that are trained on real representative samples containing actual parent compounds of drugs and explosives can and will alert to mimics based upon the dominant volatile odor compounds (VOC) found in the headspace of the parent compounds. Laboratory and field studies of drug dogs have demonstrated that they do not alert directly to the drugs cocaine and 3,4-methylenedioxy-N-methylamphetamine (MDMA or Ecstasy) but rather to methyl benzoate and 3,4-methylenedioxybenzaldehyde, respectively. In the same manner, studies have shown that explosives dogs do not alert directly to TNT based explosives (such as military dynamite) and plasticized explosives (such as C-4) but rather to 2,4-dinitrotoluene and 2-ethyl-1-hexanol, respectively. This shows the potential for alternative training methods/aids to be used in place of the more dangerous and restricted high explosives.

Using the theory based on the findings above, this study further explores the nature of the presentation of explosives for detection training and the affect that presentation quantity and accessibility have upon the detection possibility for canines. This has been accomplished by using SPME to measure the abundance of odors permeating various size openings in the presentation containers. In addition, the abundance of varying amounts of the explosive training aids was measured to determine if and how much of a difference the dogs encounter during training. The ability of solid phase micro extraction (SPME) to extract volatiles from the headspace of forensic samples has been used in conjunction with gas chromatography/mass spectrometry (GC/MS). Overall, the results demonstrate that detection of the majority of high explosives of interest can be accomplished using non hazardous training aids by the optimal selection of smokeless powder samples combined with selected COMPS developed.

Canine Detection, Smokeless Powders, High Explosives

B5 Forensic Studies of Dye and Fiber Degradation During Environmental Exposure by Microspectrophotometry and Capillary Electrophoresis/Mass Spectrometry

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After attending this presentation, attendees will have a greater understanding about the forensic methods of fiber analysis, as well as the extraneous factors that can complicate forensic comparisons.

This presentation will impact the forensic community and/or humanity by providing a more qualitative and quantitative insight into forensic fiber analysis. Explanations by trace evidence examiners for observed differences in textile fibers as a result of environmental exposure will be more convincing if accompanied by insight into possible chemical or physical mechanisms.

Textile fibers found at crime scenes are rarely found in pristine condition. The degradation of fibers and dyes can complicate the forensic comparison between questioned (evidence) and known (suspect) fibers. The objective of this research is to characterize changes that occur in textile fibers as a result exposure to environmental conditions including laundering and outdoor exposure to sunlight, heat, and moisture. Fabric samples of the most commonly used fiber types (cotton, polyester, nylon and acrylic) have been dyed with the most commonly used dyes (reactive, disperse, acid and basic) and were subjected to a variety of environmental conditions (washing, bleaching, sunlight, heat, accelerated weathering, and natural weathering) and subsequently analyzed to determine the effects of these treatments. Fabric samples were exposed to outdoor weathering (Arizona and Florida) and accelerated outdoor weathering (EMMA and EMMAQUA equivalent to 3, 6, 9 and 12-months in hot-dry and hot-wet environments). Samples were laundered with Tide®, Gain® and Wisk®, each alone, with Clorox® (chlorine bleach), and with Clorox® 2 (peroxide bleach). Small scale investigations on the effect of pool and sea water exposure are also being executed.

Fabric samples were retired from exposure at predetermined time intervals of exposure and analyzed by UV/visible and fluorescence microspectrophotometry. UV/visible and fluorescence microspectrophotometry affords the advantage of producing a distinct spectral fingerprint that can be stored and recalled for further processing. Spectral analysis of the changes in the dyed fiber spectra as a function of the exposure duration is supplemented by further analysis of selected samples using capillary electrophoresis/mass spectrometry. The advantages of CE over other analytical techniques are high separation efficiency, high selectivity, short analysis times/high sample throughput, simplicity and ease of automation, low organic solvent consumption/waste, low sample amounts required (<50 nL injected), and relatively low running costs. The efficiency (expressed as the number of theoretical plates) of CE is around 10^5 - 10^6 m⁻¹, compared to around 10^5 m⁻¹ for HPLC and 10^3 m⁻¹ for gas chromatography. In addition, CE capillaries are reusable, inexpensive, and can be used at a higher pH than most silica-based HPLC columns. Adding MS to a CE-DAD system adds qualitative identification capability (molecular mass) to the information gained from CE. Using this system, multiple dye components were analyzed at low concentrations in fiber dye extracts.

Explanations by trace evidence examiners for observed differences in textile fibers as a result of environmental exposure will be more convincing if accompanied by insight into possible chemical or physical mechanisms. A representative sampling of the environmentally exposed samples will be analyzed using automated micro-extraction techniques

followed by separation using capillary electrophoresis and analysis of the degraded dyes and deposited chemicals using mass spectrometry. Using these techniques, the level of changes induced by environmental exposure will be assessed, and also insight gained into the chemical natures of the degradation and deposition products. This chemical understanding will also assist in interpretation of spectral data and enhance the forensic significance of the results.

Fiber Analysis, Capillary Electrophoresis/Mass Spectrometry, Microspectrophotometry

B6 (GC-)IRMS Applications for Jeans and Motor Oil Investigations

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After attending this presentation, attendees will have gained an appreciation of the strong potential of (GC-)IRMS for forensic investigations.

This presentation will impact the forensic community and/or humanity by demonstrating new, interesting forensic applications of the IRMS isotopic techniques that have been developed and are demonstrated to result in much more strongly discriminating methods for forensic applications.

Introduction: IRMS is based on measuring very exactly isotope ratios for the lighter elements. The ratios of these elements vary geographically and are also influenced by chemical, physical, and biological processes. This variation offers potentially extra characteristics in the forensic characterization and comparison of materials. Forensic IRMS-applications in general are still in their infancy. In this presentation some initial results are presented for IRMS method development for blue jeans investigations and (GC-)IRMS analysis of motor oils.

Blue jeans: Fibers are important contact microtraces and as such investigated in forensics. Presently for blue jeans, only fiber class characterization investigations are made and no blue jeans fiber comparison is performed as for other fiber investigations. Similar to LA ICPMS, it may be possible to use a technique such as LA-IRMS for comparison of single fibers.

To explore the potential of a LA-IRMS method development, as a first step 24 samples of 20 used blue jeans were analyzed by EA-IRMS ($\delta^2\text{H}$, $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$, separate triple measurements for each sample). Jean samples are denoted by J1-J24 and brands used were Blue Ridge (Hij), Calvin Klein, Calzoni, (Holland design), Capsize rough choice, Jingleers, Laura, Levi Straus 501, NAF NAF, Palomino as well as some unmarked brands. Mean results of triple measurements are presented.

In these analyses EA-IRMS results vary widely with relatively large standard deviation (s) values (range, in brackets s-values): $\delta^2\text{H}$ -13.6:-62.6 (1.4), $\delta^{13}\text{C}$ -24.78:-26.31 (0.09), $\delta^{18}\text{O}$ 25.13:38.30 (0.18) (‰). Most samples are discriminated in this way.

The high discrimination obtained in this experiment demonstrates the high potential of a LA-IRMS application for blue jean fibers.

Motor oils: The characterization of hydrocarbon mixtures using GC-IRMS is of interest for various forensic areas: the characterization of motor oil as e.g. transferred in hit and run incidents when a car drives over a body, the comparison of weapon oil as transferred in gun incidents, the environmental forensics investigation of oil spills and migration through the soil and lastly comparison of hydrocarbon mixtures in arson residues with suspect accelerants from a suspect.

To explore the potential of a GC-IRMS method development, as a first step, 23 different samples of nine motor oil brands and types were analyzed by EA-IRMS ($\delta^2\text{H}$ and $\delta^{13}\text{C}$, separate triple measurements for

each sample). Motor oils are denoted by M1-M23 and types used were from the brands Shell (Helix Plus, Helix Super and X100 Super), BP (Visco2000), Total (Quartz 5000), Valvoline (Turbo V), Castrol (GTX Magnatec), Gamma (Extra), and Elf (Competition STI). Mean results of the triple measurements are presented.

The EA-IRMS results vary widely with smaller standard deviation values than for the jeans: $\delta^2\text{H}$ -92.0:-128.5 (0.6), $\delta^{13}\text{C}$ -26.55:-29.71 (0.03) (‰). For most products (motor oils from the same brand and type) a clustering of results could be observed such as for Shell Helix Super, Shell X100 Super, or BP Visco 2000. An exception appears to be Castrol GTX Magnatec with a high inter sample variation. Further experiments will be required to investigate e.g. links with variation between production batches.

Motor oil aliquots were applied to white cotton materials, then extracted using petroleum ether simulating e.g. motor oil sample collection from a T-shirt after a hit, and run incident. The extracts as well as dilutions of original motor oil samples were analyzed for $\delta^{13}\text{C}$ using a GC-IRMS instrument. Chromatographic results for two duplicate experiments using a Shell X100 Super motor oil demonstrate the repeatability of the experiments. For data processing the chromatogram was divided into four segments that were integrated separately and converted into $\delta^{13}\text{C}$ values. In this way four motor oil 'fractions' are created for which the $\delta^{13}\text{C}$ values were determined. Therefore representation of all hydrocarbon compounds is not attempted but integrated values, used.

EA-IRMS measurements for both the jeans and motor oil samples were performed at Iso-Analytical Ltd (Sandbach, UK) without further sample preparation. The IRMS used was a Europa Scientific Geo 20-20 instrument. GC-IRMS measurements were performed at TNO-NITG (Utrecht, The Netherlands) using a Thermo Electron Delta Plus XP GC-IRMS instrument.

IRMS, Motor Oil, Jeans

B7 The Forensic Analysis and Comparison of Mineral Oils Using GC-MS

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After attending this presentation, attendees will learn: (1) how mineral oils can be extracted from forensic samples and analyzed using GC-MS; (2) a scheme for the categorization of mineral oils based on their unresolved peak envelope (UPE); and (3) what types of products could potentially produce similar GC-MS results.

Little work has been published on the GC-MS analysis of mineral oils. This presentation will impact the forensic community and/or humanity by providing an efficient method for identification of mineral oils using GC-MS and also discusses the results of a comparison study carried out between several brands and types of mineral oil products.

Mineral oils are used primarily as lubricants in a wide variety of applications and are derived from crude oil. Because of their comparatively low volatility, it is not possible to analyze mineral oils by the headspace methods most commonly used to analyze volatile ignitable liquids and a separate method of analysis is therefore required.

A gas chromatography-mass spectrometry (GC-MS) method for the analysis and identification of mineral oils in forensic casework is presented. Mineral oil is applied to one surface of samples of wood and is immersed in hexane for approximately 1/2 hour. The extracts are then filtered and concentrated prior to GC-MS analysis using a DB-1 or equivalent column. Using this technique, mineral oils generate a characteristic unresolved peak envelope (UPE). Identification of mineral oil is based on the presence of a UPE eluting approximately

between eicosane (normal C20) and tetracontane (normal C40) with an almost entirely aliphatic composition.

A series of tests was carried out in which pieces of wood were spiked with various quantities of mineral oil and then extracted with hexane. Using this simple extraction, as little as 1 μ L of oil spiked onto wood could be detected.

A total of 61 mineral oil products were studied and their chromatograms were compared to assess their differentiability by GC-MS. It was not possible to determine the application type, brand, or grade of oil from the base oil chromatogram; however the oils studied were sorted into nine classifications based on UPE shape. All possible pairs of the 61 oils were compared on the basis of their UPE shapes, resolved peak detail and carbon range. Of the 1830 resulting pair comparisons, only 26 pairs were indistinguishable and only one of these 26 indistinguishable pairs was between oils that were unrelated by brand or manufacturer. In other words, 1804 (approximately 98.6%) pair comparisons had distinguishable UPE.

Oils that had been used, aged, and weathered by flame impingement could still be identified as mineral oil.

Other heavy petroleum-derived products were analyzed to determine whether or not they showed any similarity to mineral oils by this GC-MS analysis. Creosote, roofing tar, and un-evaporated diesel fuel did not produce a UPE characteristic of mineral oils. 50% evaporated diesel fuel was found to produce a UPE similar to mineral oil, however, its earlier UPE retention time range and its predominant normal alkane series (n-C12 to n-C26) provided means of differentiating it from mineral oil.

Petroleum jelly and lubricant greases were also analyzed and it was found that this technique effectively differentiated petroleum jelly, but not greases, from mineral oil. Casework examples will be presented.

This research describes an effective analytical technique for the analysis and comparison of mineral oils in a forensic context.

Mineral Oil, GC-MS, Forensic

B8 Comparison of Femtosecond (fs) vs. Nanosecond (ns) Laser Ablation Sampling Coupled to ICP-MS for the Analysis of Glass and Other Matrices of Interest to Forensic Scientists

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After attending this presentation, attendees will be able to understand the role of laser ablation ICP-MS and its impact on forensic elemental analyses.

This presentation will impact the forensic community and/or humanity by observing how laser ablation ICP-MS is great complimentary elemental technique to aid in solving trace evidence related crimes.

This presentation will investigate the utility of femtosecond laser sampling prior to ICP-MS for the elemental analysis of glass and other matrices.

Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) has become an important tool for the elemental

characterization and sourcing of samples of various matrices, including those of forensic interest. Due to its direct sampling capabilities, LA-ICP-MS offers many advantages over traditional dissolution methodologies. Such advantages include less sample consumption (nanograms compared to micrograms for dissolution techniques), the elimination of time-consuming and often dangerous sample preparation steps, an elimination of the contamination issues associated with digestion methods, and a reduction in spectral interferences. The major disadvantages of LA-ICP-MS include the requirement of matrix matched standards necessary for quantification, and the potential for elemental fractionation.

Many research groups have focused on the fundamentals of laser ablation in order to maximize both accuracy and precision; laser properties (i.e., laser-to-sample interaction), as well as sample transport from the laser ablation chamber to the ICP, remain important factors in minimizing fractionation. Therefore, when utilizing LA-ICP-MS, method optimization is crucial. Extensive research has well established that LA-ICP-MS is an excellent complementary technique to refractive index measures and fracture matching in association with forensic glass examination.¹ Glass examination continues to be an important tool in the investigation of many crimes of interest to the forensic community, including hit-and-run accidents, burglaries, and homicides.

The research presented compares the use of two different LA-ICP-MS systems, one in which a femtosecond (fs) laser is used and another that utilizes a nanosecond (ns) laser source for the analysis of glass. Previous research suggests that for nanosecond laser ablation, the ablation rate (the mass ablated per laser pulse) and fractionation is directly related to the sample matrix; thus, use of matrix matched standards is necessary for quantification.^{2,3} Femtosecond laser ablation, due to its shorter pulse duration, greatly reduces thermal damage to the sample. As a result, there is a significant reduction in sample melting, which is believed to be the cause of the nonstoichiometric ablation (fractionation) associated with using nanosecond laser sources.^{2,3} While there are matrix matched standards available for glass; this is not the case for most matrices of interest to forensic scientists.

The overall question is whether or not femtosecond laser ablation can significantly improve accuracy, precision, and discrimination power and, moreover, whether a femtosecond laser ablation system can be used for the analysis of samples *without* the need for matrix matched standards. Several parameters are considered in an attempt to answer the question. Both fs and ns sampling will be used in the analyses of certified glass standards as a means to assess accuracy, precision, and limits of detection for the analysis of these standards. A second study will determine the discrimination power (via pairwise comparison analysis) associated to each of the two laser ablation systems wherein 37 previously analyzed casework glass samples from windshields and architectural glass will be analyzed. A second discrimination study presents the results of the analysis of a set consisting of 41 vehicle windows collected between 1995 and 2005. Furthermore, the natural homogeneity/heterogeneity within a single pane of glass, namely a single windshield and a single pane of architectural glass will be presented. Finally, the use of a fs laser system without an internal standard in glass is evaluated, as this approach would increase the application of LA-ICP-MS to other matrices of interest to forensic scientists.

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ICP-MS, Laser Ablation, Glass

B9 Distributions of Elemental Concentrations Within Individual Sheets of Float Glass

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The goal of this presentation is to provide attendees with a context within which to make statistical inferences concerning the compositional similarity of fragments recovered from a broken sheet of glass.

This presentation will impact the forensic community and/or humanity by presenting data and concepts that are fundamental to the proper selection of match criteria when performing elemental compositional comparison of glass fragments.

Statistical criteria used for the comparison of element concentrations in glass fragments are typically based upon assumptions concerning sample homogeneity, the distributions of element concentrations, and independence of variables. In order to test these assumptions, a study has been performed in which the concentrations of a number of major, minor, and trace elements were determined in representative samples from three sheets of float glass. Representative samples from three panes of glass, a 4'x4' pane of 1/4" nontempered float glass and two tempered automobile side windows, were selected for analysis after dividing the sheets into squares using a grid pattern. The concentrations of up to 40 elements were determined using solution-based ICP-AES and direct solid sampling by LA-ICP-MS and LIBS. The number of replicate samples analyzed from each selected grid square was selected according to the characteristics of the sampling method. For example, larger fragments are required for a dissolution method than for laser sampling, so fewer replicates are needed to obtain a representative sample. The resulting data were evaluated graphically and by statistical tests, including ANOVA and Tukey's HSD, to determine where significant elemental differences exist within a given sheet.

The results of this study provide data that can be used to provide insight into several aspects of the evaluation of compositional data in glass. First, the results indicate the relative capabilities of the three analytical methods used, including the effects of sample size on the analytical precision and the perceived lack of homogeneity in some glass sheets. The nested ANOVA data evaluation helps to ascribe observed variations in element concentration to analytical imprecision and source heterogeneity. Second, the distributions of the analytical data, including precision measures on each data point, provide insight into whether the results meet certain statistical requirements, such as data normality required for a t-test. Finally, the multiple measures for each source allow the use of leave-one-out methods to evaluate the effectiveness of several match criteria, by directly measuring the frequency of false exclusion errors with each criterion. The data also prove particularly useful for evaluating methods of minimizing the combined error effects prevalent in multivariate comparison schemes.

Glass, Elemental Analysis, Statistics

B10 Combating the Illegal Gold Trade Using Chemical Profiling

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After attending this presentation, attendees will be made aware of the need for a procedure for the elemental and isotopic profiling of gold in South Africa and worldwide for provenance determination and the anticipated benefit to be gained from the successful implementation of a standard procedure to achieve this. Attendees will be introduced to relevant analytical techniques, and informed of current results and conclusions. Many other fields of analytical chemical investigation follow similar procedures, and still many more could potentially benefit from such profiling methods.

This presentation will impact the forensic community and/or humanity by demonstrating how an international network following universally accepted standard operating procedures is necessary to cooperatively fight precious metals theft at an international level.

The theft of gold-bearing material from the mines and plants of the Witwatersrand Basin is estimated to cost the South African gold industry R1 billion per annum, or between 0.8 and 1.6% of the annual world production of gold. As a result, identifying the original source of precious metal materials recovered during police operations is of huge financial interest, and intelligence gained in this manner also provides assistance in combating the syndicates profiting from and enabling gold theft.

Determining the profile ("fingerprinting") of gold-bearing material is a technique involving the determination and quantification of minor and trace components in the gold for provenance determination. This allows for unique characterization of materials from ores and precious metal minerals to flotation concentrates, smelter products, materials at different steps in the refining process, and finally the commercially available products.

Analytical procedures for comprehensive chemical analysis vary depending on the type and amount of material available. Routinely, XRF and ICP-OES are used for major element determination; ICP-OES is used for trace elements in metallic matrices; quadrupole ICP-MS is used for selected trace and ultra-trace element determinations in solution; and laser ablation time of flight ICP-MS is used to measure element ratios, as well as to detect *in-situ* microscopic phenomena that might be distinctive. In special cases mineralogical characteristics are identified by any combination of polarized light microscopy, scanning electron microscopy and XRD.

An extensive collection of samples from gold producers and deposits across southern Africa and elsewhere in the world has been established at the Forensic Science Laboratory in Pretoria. In addition, gold seized from illegal sources for which the provenance is known has been included in the collection. This collection is continually updated. These samples are analyzed using the techniques described above and the results are entered into a database that is linked to purpose-built statistical software. The software applies and compares two different statistical techniques in source-identification, to ensure consistency. Firstly the similarity, or dissimilarity, between a questioned sample and all other samples in the database is assessed and calculated as distances between each pair, and a probability for correct allocation is determined. The second procedure is based on Principle Component Analysis and the comparison of unknown and reference data in n-dimensional space. This allows allocation of individual analyses to material groups and probabilities are allocated for similarity to other data in the database.

This statistical analysis of the database has shown that, dependant on the size and representivity of the sample populations, it is possible to clearly discriminate between gold from within various parts of the Witwatersrand Basin, and between the Witwatersrand Basin and gold from other southern African and world-wide sources, both in the native and processed forms. Furthermore, there is a clear discrimination between bullion, manufactured gold alloys, and illegally produced gold. This ability to thus determine the provenance of gold, whether within the borders of South Africa or across borders, promises to add value to combating the illegal gold trade, and organized criminal networks on an international level.

Gold Profiling, Provenance Determination, Chemical Fingerprinting

B11 Laboratory Experiments for the Optimization of Non-Contact Human Scent Sampling

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After attending this presentation, attendees will understand the importance of careful absorber material selection in the field of human scent evidence collection as well as the scientific validation and optimization of the Scent Transfer Unit (STU-100) as a viable collection medium in non-contact human sampling.

This presentation will impact the forensic community and/or humanity by demonstrating the importance of careful selection of absorber material for scent evidence collection as well as the evaluation of the most efficient flow rate for maximum trapping capabilities of the scent sorbent material in question. Furthermore, it provides the forensic community with a scientific approach to the usefulness of the Scent Transfer Unit (STU-100) as a scent collection device for actual canine field sampling.

The increased use of human scent in criminal investigations has launched this type of evidence as a viable forensic tool to establish associations between individuals and crime scenes. Human scent discrimination by canine can be admitted into court as per the Kelly/Frye rules of evidence if the person utilizing the technique uses the correct scientific procedures and the methods used by the dog handler are reliable. Traditionally, human scent can be described as a combination of volatile compounds released from the body which are directly affected by factors such as heredity, environment, and bodily functions.

As it relates to the collection of human scent, some law enforcement agencies within the U.S. are implementing a portable device referred to as the Scent Transfer Unit (STU-100) for non-contact human scent sampling. The concept for the operation of this collection device lies in the idea that scent can be transferred from one surface to another with or without direct contact. The STU-100 uses dynamic air flow to capture human scent from the object of interest onto a sterile gauze medium. The Scent Transfer Unit allows for the ability to perform non-contact sampling using dynamic airflow and, thus, the collection of human scent from objects without contaminating or altering the object of interest. The materials and the methodology employed for scent collection have not been previously optimized or standardized within the law enforcement community. This study presents various laboratory experiments designed to optimize sample collection methods with a focus on enhancing the reliability of the Scent Transfer Unit as an instrument for collecting human scent evidence. The STU model used in this project has been modified to include a Teflon coated hood and an air flow controller. Various absorber materials of both natural and synthetic fiber composition were evaluated to optimize the flow rate

speed for collecting scent samples above a standard mixture of previously reported human scent originating volatile organic compounds. The nine different airflow rates, with air flow ranges that have been determined to be 27.3 - 46.7 ft³/min, were evaluated to establish the speed which will produce the greatest trapping efficiency of the standard mixture of compounds, which vary in functionality and include a range of molecular weights. The compounds within the standard mixture consisted mainly of five groups by functionality: alcohols, aldehydes, alkanes, acid esters, and ketones. Some of these compounds included: 2-furanmethanol, phenol, 2-furancarboxaldehyde, nonanal, decanal, 6-methyl-5-hepten-2-one, 6,10-dimethyl-5,9-undecien-2-one, octanoic acid methyl ester, and hexanedioic acid, methyl ester. The selection of the organic volatile compounds in the standard mixture was based on a previous population study investigating hand odor samples taking the highest frequency compounds detected into consideration.

Headspace solid phase micro-extraction in combination with gas chromatography / mass spectrometry (SPME-GC/MS) has been utilized as the instrumental approach for the analysis of the non-contact standard mixture airflow samples. The different absorber materials implemented in the experiments were pre-treated using a methanol-modified supercritical fluid extraction (SFE) procedure to ensure the analytical cleanliness of the collection material prior to use. The collection process consisted of placing the STU-100 device approximately 1-inch away from a 10 mL glass vial containing the standard mixture and consequently running the airflow system at varying speeds directly above the mixture for a period of 1 minute, as formulated to mirror the Federal Bureau of Investigation's Standard Operating Procedure for the collection of human scent evidence. These samples were analyzed for a period of 21 hours using a divinylbenzene/carboxen on polydimethylsiloxane SPME fiber prior to GC/MS analysis. The experiments were conducted both indoors in a laboratory environment of approximately 25°C and relative humidity of 45% as well as outdoors at an approximate temperature of 35°C and relative humidity of 90% in order to evaluate the effects of environmental contamination on the collected scent pads. The optimal flow rate was chosen based on both the presence and abundance of the compounds of interest.

Human Scent Evidence, Scent Transfer Unit (STU-100), SPME-GC/MS

B12 Comparison of the Volatile Biomarkers From Biological Specimens for Profiling Potential

Maiko Kusano, BA, and Kenneth G. Furton, PhD, Florida International University, 11200 SW 8th Street, Miami, FL 33199*

After attending this presentation, attendees will understand the difference between the volatile organic compounds present in different biological samples as well as how to evaluate the profiling potential of volatile biomarkers in blood, breath, buccal cells, sweat, and urine for metabolic profiling.

This presentation will impact the forensic community and/or humanity by demonstrating how the analysis of VOCs in biological fluids can reveal interesting diagnostic properties of different biomarkers, differentiating populations (i.e., healthy vs. illness) as well as how biological evidence collected may be useful for human identification in terms of matching individuals to odor from a crime scene. Volatile organic components of human scent play important roles in scent association between a person and evidence. Human scent identification line-ups are possible as each person has distinctive odors.

The purpose of this poster is to provide the forensic community with a comparison between the volatile organic compounds present in

different biological samples. The goal of this research is to evaluate the profiling potential of volatile biomarkers in blood, breath, buccal cells, sweat, and urine for metabolic profiling.

The human odor is made up of a variety of organic compounds such as aldehydes, alcohols, alkanes, esters, fatty acids, and ketones. Volatile organic compound (VOC) analysis in biological samples such as expired air (breath), sweat, blood, and urine has been used for various applications such as toxicology, medicine, and forensics. Over the recent years interest has increased regarding the identification of VOCs for metabolic profiling or diagnostic potentials for certain diseases that are known for its association with distinct odor.

Identification of target odor compounds can provide valuable information to both the medical and forensic communities. From the medical perspective, analysis of VOCs in biological fluids can reveal interesting diagnostic properties of different biomarkers. In addition to the disease diagnostic potential, analysis of VOCs in biological samples may be useful in differentiating populations (i.e., healthy vs. illness). From the forensic perspective, biological evidence collected may be useful for human identification in terms of matching individuals to odor from a crime scene. Volatile organic components of human scent play important roles in scent association between a person and evidence. Human scent identification line-ups are possible as each person has distinctive odors. Canines have the ability to discriminate human scent because people smell different.

Because odor signatures are unique, human scent evidence provides an invaluable means of aiding in the identification of possible suspects. Law enforcement agencies have utilized visual line-ups to identify suspects for decades. However, visual line-ups may be impractical at times when individuals alter their appearance. It is also true that eyewitness testimony has come under increasing scrutiny over the past years because of its unreliability. Scent evidence remains constant, and whereas physical evidence such as blood and hair can be removed from the crime scenes, scent evidence may linger for a longer period of time.

Curran et al. have detected and identified the VOCs present in human odor from sweat samples using solid phase micro-extraction gas chromatography mass spectrometry (SPME-GC/MS). They have shown that human scent is a combination of various compounds differing in ratio from person to person as well as other compounds that varied among individuals. These differences in compounds and ratios have not yet been extended to different biological specimens beyond sweat and hand odor.

There is currently no direct comparison made between the volatile organic compounds present in different biological samples (blood, breath, buccal cells, sweat, and urine). Therefore the question of matching VOCs present in human scent compounds across various biological samples still remains unanswered. In this study SPME-GC/MS was utilized to extract, separate, and identify the volatile components from the collected biological samples. The purpose of this research is to evaluate the potential of headspace SPME-GC/MS for profiling VOCs from different biological samples.

Collections of biological specimens were optimized. Hand odor samples were collected on a pre-treated 2 x 2 sterile gauze pad. Expired air was sampled in a Teflon breath sampling apparatus. Whole blood was obtained by finger stick sampling and collected into capillary tubes. Urine and buccal cell specimens were collected under typical forensic evidence collection methods, which were immediately transferred into 10 mL headspace vials. It has been shown that the abundances of the VOCs from hand odor samples can be used to differentiate individuals. Other biological specimens show some common VOCs but also significant differences. The differences observed for the VOCs from different individuals and different population sets has potential for use in characterizing the individual, but additional samplings and a larger population study is needed to make conclusions regarding this potential.

Human Scent, Volatile Biomarkers, SPME-GC/MS

B13 Evaluation of a Hand-Held Raman Instrument for Identification of Hazardous Substances

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After attending this presentation, attendees will understand the strengths and limitations of a rapid method for bulk identification of hazardous substances using Raman spectroscopy.

This presentation will impact the forensic community and/or humanity by increasing awareness of the strengths and limitations of a hand-held Raman instrument for bulk identification of hazardous substances.

Raman spectroscopy is a rapid, powerful, non-destructive analytical technique that is being used by hazardous materials and explosives response teams to assist in the identification of unknown substances in the field. Portable instruments have been used to attempt to identify hazardous chemical and biological materials, drugs, explosive compounds, and unstable substances sensitive to light, heat, or shock. In response to current needs, Ahura Corporation designed the First Defender™ - a hand-held, light-weight, self-contained Raman spectrometer for rapid material analysis. The Counterterrorism and Forensic Science Research Unit, the Hazardous Materials Response Unit, and the Explosives Unit at the FBI Laboratory have joined to conduct a performance evaluation of the First Defender™ as tool for field investigative purposes. This presentation will report on the accuracy of the hand-held Raman unit in the analysis of known pure substances and mixtures.

Field Investigative, Unknown Identification, Raman Spectroscopy

B14 Effect of Cyanoacrylate on DNA Typing of Human Fingerprints

Sorada Pitilertpanya, and Timothy Palmbach, JD, University of New Haven, 300 Boston Post Road, West Haven, CT 06516*

After attending this presentation, attendees will learn the best method for recovery of human DNA from superglue fuming fingerprints.

This presentation will impact the forensic community and/or humanity by describing the best method for recovery DNA from fingerprints.

The purpose of this experiment is to know the effect of superglue fuming on the object to enhance fingerprints but still allow for recovery of DNA from the person.

Cyanoacrylate or superglue is one of the most well-known methods for detection of latent fingerprints in forensic analysis. It works well on non-absorbent surfaces. Fingerprints are composed of many complex chemical components such as amino acids, fatty acids, hydrocarbons, and proteins. The epithelial cells can be found on the print residue by sloughing off the skin surface through rubbing of the skin or through direct contact with a substrate. In some cases, the detection of fingerprints at the crime scene is useless because of smudging of the prints or many fingerprints appear on the object at the same point so detection of DNA from the fingerprints may be more useful. The use of Polymerase Chain Reaction (PCR) analysis has allowed small quantities of DNA to be detected.

The recovery of human DNA from soda cans that have been previously treated with cyanoacrylate or superglue to enhance latent fingerprints is possible. For these experiments, The QiaAmp (Qiagen, Valencia, CA, USA) extraction kit was used to extract DNA by using a tissue extraction method and elution buffer of 30 µL per one sample. The DNA samples were amplified with AmpF/STR® Cofiler™ kit (Applied Biosystems, Inc. Foster City, CA USA). In the experiments, two types of chambers were used. The first one was a portable plastic chamber and superglue wand that can be used in routine forensic laboratories or at crime scenes. The second one was a CYANOSAFE™ Filtered Cyanoacrylate Fuming Chamber (Sirchie® Fingerprints Laboratory, Inc. Youngsville, NC, USA) which is the automatic superglue fuming chamber. It needs only a small amount of superglue and some water put in a small cup and preset the time. Both chambers provide good results of superglue enhancement on the fingerprints and a DNA profile. The profiles from superglue fuming in the plastic chamber with the superglue wand for 30 minutes gave good fingerprint patterns. Fingerprints can be seen clearly and can be swabbed by using a cotton bud soaked with acetone. The use of acetone to recover the DNA from a fingerprint sample is not a standard practice in most forensic laboratories that use water, a saline solution, or scraping for recovery. DNA can be extracted from fingerprints fumed with superglue from 20-40 minutes. The best results came from fuming for 20-30 minutes. The more superglue used, the worse the DNA profile results. The DNA results were both full and partial profiles depending on the quality of the fingerprints. From these experiments, it was determined that fingerprints on dry surfaces gave better DNA profiles than from wet surfaces. Although a wet surface gives partial profiles, it displayed variable results for recovery from experiment to experiment. From some experiments, DNA can be extracted from a single fingerprint but it was often a partial profile. The more fingerprints combined together into one sample, the better the DNA profile results suggesting recovery of DNA is from very few cells (low copy number approach). The negative control untreated fingerprints provided better DNA profiles than the superglue fuming fingerprints showing it is the fuming process and sample recovery technique that affects the DNA test.

Cyanoacrylate or superglue affected the extraction of DNA by decreasing the quantity of DNA. However, using acetone and by combining fingerprints, DNA can be extracted and results obtained from the superglue fuming fingerprints.

Cyanoacrylate, Fingerprints, DNA

B15 Experiments in Forensic Science Administration Help in the Design of Error Discovery

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After attending this presentation, attendees will learn how experiments in forensic science administration can inform the design of error-discovery mechanisms. This knowledge can be implemented by creating cross-lab control measures that support self-policing mechanisms in forensic science.

This presentation will impact the forensic community and/or humanity by revealing both the correct principles and fine details of how to institute cross-lab control measures to reduce error rates in forensic science and other areas. Reducing error rates in forensic science will benefit society by improving justice. Reducing error rates in medical testing will benefit society by improving health. Mistakes in medicine and the criminal justice system are costly. The project will benefit

society as a whole by lowering incidence of such mistakes and thus their cost. Further benefits to society are likely to follow from the application of the methods and principles of the study to other lab-based social processes such as the lab-based natural sciences.

All lab-based social processes including pure science, medical testing, drug screening, and forensic science are subject to errors. None has an error rate of zero, in spite of the best efforts and intentions of participants in them. There are many causes for errors in lab-based social processes, all rooted in the simple fact that humans are imperfect. Important among these reasons is the relationship between the decision making of lab personnel and the organizational structure of any lab-based social process. Participants in lab-based social processes respond to the structure of the network relating one lab to another. In pure science there is a complex set of network relationships among labs, whereby results produced in any one lab are subject to challenge from other labs. This network structure creates a self-policing system that seems to have improved the reliability of pure science. In forensic science and some other areas, the results from any one lab are unlikely to be challenged by any other lab.

The radical difference in network structure in forensic science and pure science suggests the possibility of reducing error rates in forensic science by altering its network structure to look more like that of pure science. This conjecture is strengthened by the apparent facts concerning errors in pure science. The errors that do occur seem to be concentrated where reproducibility is hardest and where, therefore, the network structure of pure science is weakest.

In the past, there has not been enough reliable, empirically grounded scientific knowledge of the relationship between lab performance and network structure. Improving the reliability of lab-based social processes means improving such knowledge. Improved knowledge will make it possible to develop improved procedures and protocols for crime labs and other areas. The procedures and protocols emerging from the project under discussion go beyond what can be applied within a given lab to involve redesigning the network structure of the lab system.

The presentation explains how the research team is using experimental techniques to study the connection between error rates and network structure. Results so far suggest a strong connection and the possibility of reducing error rates through a reorganization of the network structure of forensic science. The practical implication is to institute cross-laboratory control measures to reduce the probability of errors occurring.

Laboratory Analysis, Experimental Error, Error Reduction

B16 Comparison of Blue Gel Ink Pens Through Chemical and Optical Methods

Nicole Deitz, Lawrence A. Quarino, PhD, and Donna Mohr, PhD, Cedar Crest College, 100 College Drive, Allentown, PA 18104*

After attending this presentation, attendees will understand the use of chemical and optical methods in the identification of blue gel inks. The presentation will provide a systematic way for document examiners and forensic chemists to identify blue gel inks.

The results of these methods were used to create a flow chart that can be used in the identification of gel inks. The creation of the flow chart will impact the forensic community and/or humanity by creating a procedure for identifying gel inks from questioned documents and to elaborate on traditional methods of identifying gel inks.

The increased popularity of the gel ink pen has created a need for professionals involved in the identification of inks to be able to classify and differentiate them from other pen types. The historical method of identifying inks has been thin layer chromatography (TLC), but as many gel inks are pigment based this technique is of only nominal use. To differentiate twenty-one blue gel inks, this study used optical and

chemical techniques. Of the twenty-one blue gel inks, seven were dye-based and fourteen were pigment-based. The optical techniques used were stereomicroscopy, light microscopy, phase contrast microscopy, and fluorescence microscopy. Attempts at chemical differentiation of the blue gel-based inks included differential solubility, thin-layer chromatography, and Fourier Transform Infrared (FT-IR) spectroscopy using the IlluminatIR®.

Solubility tests using various solvents indicated that dye-based inks showed varying degrees of solubility and that the resulting color with certain solvents could differentiate some of the dye-based inks. The pigment-based inks showed only partial solubility with 5% NaOH and no solubility with the other solvents. As a result of lack of solvent solubility in the pigment-based inks, only the dye-based inks could be distinguished using thin-layer chromatography. Samples were distinguished using a mobile phase of ethyl acetate: ethanol: water (75:35:30) on a variety of plate types. Plates with aluminum, glass, and plastic backing yielded no difference in sensitivity. Additionally, two of the pigment-based inks could be distinguished from the others based on fluorescence of separation products under both shortwave and longwave UV light.

The FT-IR analyses of the inks produced similar spectra for all the gel inks, so it did not assist in the differentiating the gel inks. The peaks observed on the spectra were more indicative of the material used to create the gelatin nature of the inks such as xanthan gum.

Using fluorescence microscopy, the dye-based inks showed little to no fluorescence whereas the fluorescence of pigment based-inks was abundant. In addition, there was variation in fluorescence for the pigment-based pens in both color and intensity thereby allowing for the identification of each of the fourteen pigment-based inks used in the study. Conversely, phase contrast microscopy showed more success in differentiating between the dye-based inks than in the pigment-based inks. Stereomicroscopy and light microscopy showed little ability to distinguish either the gel-based or pigment-based inks.

Gel-based Inks, Microscopy, Chemical Analysis

B17 Forensic Discrimination of Ink Samples Using UV/Visible Microspectrophotometry and Multivariate Statistics

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After attending this presentation, attendees will understand improvements in forensic document examinations for casework studies.

The designed experiments performed in this research, combined with analytical discrimination achieved among inks on questioned documents, will impact the forensic community and/or humanity by suggesting improvements in forensic document examinations for casework studies.

The goal of this presentation is to determine the usefulness of UV/visible microspectrophotometry (MSP) and multivariate statistics to discriminate between similarly colored ink samples.

This research addresses the needs of forensic document examiners to discriminate between ink samples written on questioned documents. The examination of questioned documents often includes separation, identification, and quantitation of the ink deposited onto paper during the writing process. The diverse chemical structures of colorants and other components in ink provide a chemical basis for the ability to discriminate and identify their characteristic component materials. Frequent issues include determining the age of the writing/document, whether the same pen was used on two different documents, whether multiple entries were written at the same time, or whether a document was altered. Ball point, fountain, felt tip, and gel pen inks have different

compositions and properties. Inks are mixtures of a wide range of chemical compounds that include cationic or anionic colorants and a liquid portion known as the “vehicle.” The vehicle (solvents, waxes, resins, and oils) aids in the flow and drying characteristics of the ink as it leaves the pen. Driers, plasticizers, greases, soaps, and detergents may be added to the ink and vehicle for other desired characteristics. In matching a questioned writing sample to a standard ink, the identities and concentrations of the ink components, along with the vehicle and other components that solubilize the ink, can provide a molecular “fingerprint” of the ink.

Samples from various brands of black, blue and red ink pens were collected to test the ability of UV/visible microspectrophotometry to discriminate pen inks. This study involved ball point and gel ink pens only. Ink samples from the same pen, from pens of the same exact type, and from pens of similar color but containing different chemical components were also included in the experimental design. One microliter of ink was sampled from each pen with a pipette, dissolved in 10 microliters of methanol, dispersed onto a microscope slide, and dried before analysis. Ink samples were also extracted from ink on documents and analyzed in the same manner to test differences that might arise in inks on paper and as a result of aging on the document. The MSP was operated in transmission mode using a xenon source and a 35X collecting objective. Characterization of ink samples using UV/visible microspectrophotometry offers simple, direct, non-destructive analysis of ink on questioned documents. Spectra of selected ink samples were analyzed using principal component analysis and linear discriminant analysis. These multivariate statistical tools facilitate the visualization of differences among spectra and the identification of spectral features that differentiate ink samples from one another.

The designed experiments performed in this research, combined with analytical discrimination achieved among inks on questioned documents, may suggest improvements in forensic document examinations for casework studies.

Document Examination, Multivariate Statistics, Ink Analysis

B18 Evaluation of Field Tissue Storage Methods Optimal for Preserving DNA

Rith R. Yim, BS, and David R. Foran, PhD, Forensic Science Program, Michigan State University, 560 Baker Hall, East Lansing, MI 48824*

After attending this presentation, attendees will learn about field tissue storage methods that can be implemented for optimal preservation of DNA with respect to various stages of decomposition, tissue types, tissue storage times, and seasonal/environmental influences. The success of forensic DNA analysis on recovered human remains largely depends on the quality and quantity of DNA present. Identifying superior tissue storage techniques is pertinent for preserving intact high quality DNA, which would increase the likelihood of successful human identification.

This presentation will impact the forensic community and/or humanity by identifying tissue preservation methods that are suitable for field application and long term tissue storage without compromising the success and ease of subsequent DNA analysis. This information will be useful for first responders, mass disaster response teams, law enforcement, medical personnel, crime scene technicians, and those seeking a tissue storage method for implementation on-site.

It is ideal to collect and preserve samples from decomposing remains as soon as possible to impede or reduce DNA degradation, which will increase the chances of successful downstream DNA analysis and identification. However, in instances of mass or natural disasters, rarely are tissue samples preserved for future DNA analysis as soon as the human remains are found; there is often a delay in tissue preservation

due to time spent on recovering, documenting, and processing the discovered remains. Any lag time in tissue preservation may also be lengthened when scenes are in remote locations that are hard to access, along with there being no rapid and simple means of tissue storage available. Thus, identifying a quick and uncomplicated tissue storage technique that aids in prompt preservation of DNA is beneficial to the forensic community.

The tissue storage methods examined in this research were intended to be simple, rapid, cost effective, and would not require any extensive or specialized training to implement, making it more conducive to emergency situations. The portability, toxicity, obtainability, and stability over time at room temperature of the storage media were also taken into consideration for ease of use in the field.

Tissue samples collected were preserved in a DMSO salt solution, isopropanol (100%, 70%), ethanol (100%, 70%, 40%), and silica desiccant. Tissue samples were also frozen at -80°C or left unpreserved, for comparison to the preserved samples. Pig carcasses were placed during the summer and winter seasons in a field to decompose. Tissue sections of muscle and skin were collected on-site from the pigs immediately after sacrifice and every 3 days thereafter. The collected tissues were sectioned into 0.2-0.3 g portions and preserved using the different storage methods. Samples were stored for three time periods: 1 week, 2 months, and 6 months. After tissue storage, DNA was isolated from the samples using a standard organic extraction method. The DNA extracts were assayed on a yield gel to determine if there was abundant high molecular weight DNA present. DNA quality was examined by amplification of three pig-specific PCR fragments of increasing length. Real-time PCR was used to assess the quantity of DNA in the samples.

The quantitative and qualitative approach implemented in this research will provide a more accurate assessment of DNA preservation among the different storage methods examined. The tissue storage method that excels in preserving high quality and quantity DNA across longer storage time, increased level of decomposition, seasonal/environmental influences, and different tissue types, coupled with the technique being simple and rapid, would be a superior method for tissue storage in the field.

DNA Preservation, Mass Disasters, Tissue Storage

B19 Evaluation of Zeolite as a Substrate for Collection and Storage of DNA

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After attending this presentation, attendees will have learned about the chemical composition of zeolites, the value of zeolite in collection and storage of blood, the results of DNA extraction from blood stored on zeolite over time, and the results of DNA extraction from other biological fluids collected with zeolite.

This presentation will impact the forensic community and/or humanity by demonstrating a new method of recovering blood at crime scenes for later analysis which would reduce the possibility of exposure to blood borne pathogens by crime scene and law enforcement personnel. This type of recovery of DNA from the used bandages synthesized with zeolite may also be useful for military investigations.

There has been a development in the area of battlefield medicine, consisting of a hemostatic agent made of unique materials. This is the QuikClot® hemostatic agent, made of zeolite, a silicate made from equal parts silicon tetroxide (SiO₄) and aluminum tetroxide (AlO₄). To acquire hemostasis, zeolite in the QuikClot® absorbs liquid in the blood, which is an exothermic reaction. The positive results from this bandage have been so promising that QuikClot® has already been deployed to armed forces and law enforcement agencies.

This study has been initiated to determine the efficacy of recovery of DNA from blood bound in the zeolite. There are four areas of interest in this study: 1. Recovery of DNA after introducing it to the zeolite; 2. Recovery of DNA from blood samples (whole blood) immediately following deposition onto the zeolite; 3. Recovery of DNA following storage of blood mixed with the zeolite at -20°C freezer for periods of 1 week to 4 years and; 4. Recovery of DNA following storage of blood mixed with the zeolite at room temperature for periods of 1 week to 4 years (beginning in June 2006 and ending in June 2010). These last two areas of interest are to determine the efficacy of using such materials for storage of blood samples for DNA recovery that may be useful for DNA databases. Preliminary tests resulted in successful extraction of the DNA sample. Analysis of saliva, sweat, and semen will also be tested using the same substrate.

It is felt that the application of this study has potential for demonstrating a new method of recovering blood at crime scenes for later analysis which would reduce the possibility of exposure to blood borne pathogens by crime scene and law enforcement personnel. Additionally, there is the potential of using this agent as a means for obtaining DNA samples of suspects, who might use such products in an attempt to self-treat wounds received in violent encounters with law enforcement officers in order to avoid situations where the suspects put themselves at risk for detection and arrest, i.e., arriving at a hospital emergency room, seeking treatment for gunshot wounds. Furthermore, recovery of DNA from the used bandages may be useful for military investigations, as QuikClot® has already been deployed to U.S. armed forces.

Zeolite, DNA Extraction, Storage

B20 Enhancement of Sperm Cell Recovery From Cotton Swabs for Rape Kit Analysis: Anionic Detergent-Mediated Cell Elution in the Absence of Proteinase K

Jessica C. Voorhees, MS, Kate Manning, Jerome P. Ferrance, PhD, and James P. Landers, PhD, University of Virginia, Department of Chemistry, McCormick Road, Charlottesville, VA 22904*

After attending this presentation, attendees will have learned about an improved method for the elution of cells from a cotton swab evidence sample collected from a sexual assault victim.

This presentation will impact the forensic community and/or humanity by demonstrating an alternative to conventional differential extraction for increased recovery of biological materials from cotton swabs in an effort to improve recovery of sperm cells for DNA extraction and genetic identification.

The focus of this project is the development of an improved method for the elution of cells from a cotton swab evidence sample collected from a sexual assault victim. The procedure incorporates a detergent solution for increased recovery of biological materials from cotton swabs, in an effort to improve recovery of sperm cells for DNA extraction and genetic identification.

Genetic analysis of mixed profile DNA samples obtained from vaginal swabs is a well-established technique in the investigation of sexual assault and rape cases. Unfortunately, the procedures involved in a typical forensic DNA analysis require that significant laboratory time be dedicated to a single case, particularly in the sample preparation steps. Because of time and funding constraints involved in the investigation of such cases, a significant backlog exists in many DNA analysis laboratories.

The current protocol for recovery of genetic material from cotton swabs, known as differential extraction (DE), involves significant

sample handling and is time-consuming, often requiring overnight incubation of a swab sample. The solution used for DNA recovery from swabs includes proteinase K and a detergent, the combination of which selectively lyses epithelial cells while eluting sperm cells intact. Centrifugation pellets the sperm cells, separating them from female DNA in solution from the lysed vaginal epithelial cells. Although this treatment decreases the number of vaginal cells present in the sperm cell suspension, sperm cell lysis and subsequent loss of valuable evidential material often occurs during the proteolytic digestion step of the traditional DE process. The DE method, therefore, does not always provide for efficient independent genetic analysis of the separated male fraction.

Microchip technology offers a rapid, cost-effective alternative to conventional DNA analysis methods. Techniques performed on microchips are particularly advantageous because they can be integrated with downstream analytical steps on a single microfluidic device in the form of a lab-on-a-chip device. Implementation of integrated systems for forensic DNA analysis will reduce analysis times, and, therefore, the forensic casework backlog. However, traditional isolation of separate sperm and epithelial DNA fractions using DE incorporates centrifugation steps, which are not easily implemented on a microchip. Microchip methods for isolating intact male and female cells have been reported^{1,2}, but the overall effectiveness of the procedure is ultimately dependent on the efficiency with which material can be eluted and recovered from a cotton swab.

Previous studies have shown that intact sperm and epithelial cells can be recovered from swab samples using enzymatic digestion of the cotton matrix³; this method, however, did not enhance sperm cell recovery over the traditional DE buffer. Current studies focus on treatment of the swab samples with anionic detergents to enhance sperm cell recovery, and show that a considerable fraction of sperm cells are lysed by the proteolytic digestion utilized in the conventional DE method.⁴ To optimize cellular elution conditions, several detergents were evaluated, with the sperm and epithelial cells eluted from each cotton swab sample counted using a hemacytometer. Results indicate that elution using anionic detergents over neutral or cationic detergents improved the recovery of sperm cells in less time than required for conventional DE. Optimum cellular elution conditions using detergents will be presented. In addition, information regarding the development of alternative preferential lysis methods will be discussed.

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Cell Elution, Anionic Detergent, Differential Extraction

B21 The Singapore National DNA Database Laboratory

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After attending this presentation, attendees will understand how the Singapore National DNA Database maintains its integrity of the DNA

profiles uploaded into the Singapore National DNA Database by duplicating the processing of each FTA sample, the system of positional checks of each FTA punch in every PCR plate, and the approval of identical reviewed DNA results from both independently processed PCR plates.

This presentation will impact the forensic community and/or humanity by demonstrating the setup of the DNA database laboratory in ensuring the integrity of the DNA profiles uploaded into the Singapore National CODIS database.

In the design of the Singapore National DNA Database Laboratory, several review processes have been built to ensure the integrity of the evidence and the DNA profiles that are uploaded into the CODIS database. The systems are supported by both the design of the Laboratory Information Management Systems (LIMs) as well as checks performed by the laboratory staff.

This presentation will impact the forensic community and/or provide humanity by demonstrating the setup of the DNA Database Laboratory in ensuring the integrity of the DNA profiles uploaded into the CODIS database.

The Singapore National DNA Database Laboratory was launched on 14 February 2003. On its launch day, close to 14,000 blood-stained FTA™ cards were submitted from all the prisons in Singapore which took the laboratory approximately 8 months to complete processing. On a daily basis, approximately 60 samples are submitted to the laboratory.

All FTA™ samples submitted to the laboratory come with a unique barcode. Upon receipt, the sample is logged into LIMs, which will generate a unique laboratory number which is assigned to each submission. Each FTA™ card will be processed in duplicate. A 1.2 mm punch disc will be excised from the FTA™ card into a 96-well PCR plate. This process is repeated to obtain a second 96-well PCR plate of FTA™ punch discs. Before any punch disc is excised from the FTA™ card, the laboratory number of the FTA™ card is captured by the barcode reader attached to the DBS Wallac Puncher, generating a text file documenting the barcode it has captured at the end of completion of the punch process. Similarly another text file will be generated when the second PCR plate is completed. These two text files are uploaded into the LIM system, where it would be compared to check the identical punch sample is in the same PCR well in both PCR plates, ensuring sample integrity. The FTA™ discs in each PCR plate will then be processed using a Beckman Coulter® Biomek® 2000 robotic workstation, followed by PCR. Transfer of PCR products for genotyping is also performed by a second robotic workstation. DNA profiles generated from the two PCR plates having the same FTA™ samples will be read by an analyst. A separate analyst will also read one out of the pair of PCR plates. The two analysts will interpret the DNA results independently and generate a LIMS table. The DNA results in the LIMS table will be compared against one another, using an in-house Excel spreadsheet to check for any interpretation differences. The DNA results from both sets of PCR plates will then be uploaded into the LIM system, where the DNA profiles from both PCR plates will be compared. Only when results from both PCR plates are identical would the LIM system grant approval of the results for direct upload into the CODIS database.

In conclusion, the integrity of the DNA profiles uploaded into the Singapore National DNA Database is maintained by:

- a) Duplicate processing of each FTA sample
- b) System of positional check of each FTA punch in every PCR plate well
- c) Approval of identical reviewed DNA results from both independently processed PCR plates

DNA Database, FTA, CODIS

B22 Method to Determine Collection Efficiency of Particles by Swipe Sampling

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After attending this presentation, attendees will understand alternative methods of particle collection for trace analysis, compared to tape pulls or vacuum collection. Various sample surfaces, particle sizes, and ideal collection traps will be discussed.

This presentation will impact the forensic community and/or humanity by suggesting alternative ways to collect trace evidence as compared to tape pulls and vacuum collection, along with the ideal surfaces from which to collect trace particles.

A methodology was developed to evaluate particle collection efficiencies from swipe sampling of trace residues. Swipe sampling is used for many applications where trace residues must be collected, including the evaluation of radioactive particle contamination and the analysis of explosives and contraband at screening checkpoints using Ion Mobility Spectrometry (IMS), along with Gas Chromatography-Mass Spectrometry (GC-MS), High Performance Liquid Chromatography (HPLC), and other analytical tools. Collection efficiencies were evaluated for micrometer-sized polystyrene latex (PSL) spheres with respect to particle size and mode of deposition, collection trap, surface type, and swiping force. The types of surfaces sampled in explosives screening environments include the exteriors and interiors of carry-on luggage, laptop computers, upholstery, clothing, etc. Four test surfaces were selected to represent some of the target surfaces at screening venues in airports. These include: 1) a textured vinyl, 2) a smooth vinyl, 3) a stiff cotton fabric, and 4) a thin nylon fabric. Collection traps used included a woven cotton cloth (muslin), a polytetrafluoroethylene (PTFE, also known as Teflon)-coated woven fiberglass trap, and Swiffer Sweeper® dry cloths. Although particles are likely to be non-spherical, and can be expected to be in a heterogeneous matrix containing the sebaceous materials (body oils) common to latent fingerprints, the use of spherical particles was chosen because of the ability to control particle size and to simplify particle counting (through use of a fluorescent tag). The particles are deposited in two ways, either dry, or in a matrix of sebaceous material. Test surfaces containing particles were prepared under controlled conditions and swiped with a reproducible technique that allows for the evaluation of frictional forces. Collection efficiencies were determined by optical imaging and particle counting.

Of the two IMS collection traps studied, the PTFE trap has significantly lower collection efficiencies. This is likely to be due to a combination of texture and composition. The larger (42 µm) particles are collected more efficiently than the smaller (9 µm) particles. Particles in a matrix similar to latent fingerprints are collected more efficiently than dry particles. Applying greater normal force during swiping does not greatly improve collection efficiencies. This fact, coupled with the observation that many particles are detached but not collected, implies that improvements in collection efficiency are dependent on improvements in adhesion of the particles to the collection surface, rather than larger forces to detach the particles. This is supported by the fact that particles embedded in sebum, which is a sticky matrix, are collected more efficiently than the dry particles. A lack of adhesion of the particles to the collection surface may also explain the poor collection efficiency of the PTFE trap. Overall, the highest collection efficiencies are observed for the largest particles (42 µm) embedded in sebum collected with the muslin trap. Under these conditions, close to 100 % collection efficiencies can be achieved from three of the four test surfaces. The cotton canvas surface is not amenable to swiping with the two traps studied. The collection efficiencies are routinely poor for this surface, probably due to trapping of the particles in the weave of the fabric during swiping.

Ion Mobility Spectrometry, Trace Analysis, Particle Collection

* Presenting Author

B23 Genetic Variation at 15 Forensic Informative STR Loci in Upper (Southern) Egyptians

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The goal of this presentation is to present the forensic genetic characters of fifteen autosomal short tandem repeat loci (STRs) in a population sample from Upper (south) Egypt. Allele frequency distribution of the used loci along with application of other forensic indices and population differentiation tests in this ethnic group will be addressed. Furthermore, comparison of the yielded data to other related populations either in local or global level is another important goal. The questions considered are: 1) how could the examined loci help in estimation of DNA profile frequency in forensic situations in relation to that population? and 2) could the data differentiate Upper Egyptians from Lower, other geographically and historically relevant populations?

This presentation will impact the forensic community and/or humanity through building up and developing a forensic population database for different ethnic groups and regions in Egypt, which can be implemented in medico-legal practice at both personal identification and ethnic affiliation levels.

Forensic databases had been established for several populations all over the world however, they are still lacking in Middle Eastern countries including Egypt. From the earliest times of history, Egyptians always referred to their country as "Two Lands," meaning the land of the North (Lower Egypt) and the land of the South (Upper Egypt). This ancient classification has led to the persistent ethnic division of Egyptians into two main groups: Lower (Northern) and Upper (Southern) groups. The present study is focused on the southern ethnic group residing in an area extending from south of Cairo to Aswan along the narrow River Nile valley. The residents are Arabic language speakers with a dialect distinguishable from the Northern population.

A sample of 265 unrelated individuals inhabiting south Egypt for at least up to the third generation in a subset of that area's governorates (a total of five) were collected after signing informed consents. Afterwards, the samples were subjected to DNA extraction by a silica-based method, quantitation and multiplex PCR amplification using the AMPF®STR Identifiler kit (containing 15 loci: D8S1179, D21S11, D7S820, CSF1PO, D3S1358, TH01, D13S317, D16S539, D2S1338, D19S433, vWA, TPOX, D18S51, D5S818 and FGA). PCR products were genotyped subsequent to capillary electrophoresis. Statistical analysis of the generated data aimed at estimating allele frequencies for each locus, followed by testing for suitability of the used loci in determination of random match probabilities in forensic practice. This was achieved through testing for Hardy-Weinberg equilibrium (HWE) for alleles' independence and linkage equilibrium (LE) for loci independence. Furthermore, important forensic indices such as the values of heterozygosity (H), polymorphic information content (PIC), power of discrimination (PD), power of exclusion (PE), paternity index (PI) and matching probability (MP) were considered for each locus. Population differentiation tests e.g. Fst genetic distances and pair-wise analysis of molecular variance (AMOVA) are other useful parameters for comparative study of the present population data to other related ones. Preliminary results indicated neither departure from expectation of the HWE in most of the tested loci nor dependence of alleles between loci, allowing multiple locus profile frequency estimation in forensic situations using the product rule. All tested loci were polymorphic; the most discriminating is D18S51 while the least is TPOX.

Forensic, STRs, Upper Egyptians

B24 Detection of Sequence Variation in Caucasian and Hispanic Samples Across the Mitochondrial Genome Using an 83 Immobilized SSO Probe Panel

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The goal of this poster is to present results from a population study conducted to investigate sequence variation in Caucasian and Hispanic DNA samples using a panel of 83 SSO probes immobilized on a nylon membrane and to determine the power of discrimination for these populations.

This presentation will impact the forensic community and/or humanity by providing practitioners with additional data on the frequency of polymorphic sites outside of the commonly targeted HVI/HVII regions of the mitochondrial genome.

Currently, a 31 probe panel that targets polymorphic regions within hypervariable regions I and II (HVI/II) is commercially available. Although forensic laboratories have successfully used this assay to make exclusions in casework, there are limitations to targeting just the HVI and HVII regions independent of the method of analysis (HVI/HVII sequencing or linear array typing). Seven percent of Caucasians share the same HVI/II sequence and 11% share the same HVI/HVII type, as determined by the linear array assay. Similarly, there are two common HVI/II types shared amongst Hispanics. To further distinguish these common HVI/II types and increase the discrimination power, a probe panel targeting the most discriminating polymorphic sites located in the variable and coding regions was developed. Results from a population study will be presented here, including frequency and genetic diversity calculations.

An intermediate probe panel, consisting of mtDNA HVI/II probes and additional coding regions probes (56 probes total), has been developed and tested on Caucasian and Hispanic samples. A population study including 88 Caucasian samples was conducted using the 56 probe panel and preliminary results indicate that significant increases in the detection of overall genetic diversity can be obtained. When typed with only the HVI/HVII linear array an h value of 0.973 is obtained. However, the h value is increased to 0.992 using the 56 probe panel (HVI/HVII and 25 additional probes), which is nearly as informative as the h value obtained from HVI/HVII sequencing (0.994). A population study including 91 Hispanics was also conducted using the 56 probe panel. Preliminary results from this study show that with the addition of the 25 probes, the two common Hispanic HVI/HVII types can be further distinguished and an increased h value can be obtained. The most common Hispanic HVI/HVII type can be further subdivided into ten groups when using the 56 probe panel. Similarly, the second common Hispanic HVI/HVII type can be further subdivided into five smaller groups. Preliminary calculations indicate that when these 91 samples are typed with only the HVI/HVII linear array, an h value of 0.944 is obtained. However, with the addition of the 25 new probes the h value is increased to 0.989. Results from the combined 83 probe panel will also be presented here. The discrimination power of the combined 83 probe panel will be greater than that of HVI/HVII sequencing for all populations.

Mitochondrial DNA, Linear Array, Immobilized SSO Probes

B25 The Development of a Highly Informative, Hierarchical Multiplex SNP Typing System to Predict Ethnogeographic Ancestry Using Pyrosequencing Technology

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After attending this presentation, attendees will be informed of new highly discriminating Y-SNPs and their potential use, in combination with mtSNPs and autosomal SNPs, for predicting the ethnogeographic ancestry of an individual.

This presentation will impact the forensic community and/or humanity by showing attendees the potential uses of Y-SNPs, whether alone or in combination with STRs, as a tool in human identification.

The ability to determine ethno-geographic origin of an individual can potentially provide descriptive information of an unknown individual who deposited a biological stain at a crime scene, therefore serving as a genetic eyewitness. This can potentially be accomplished with the careful selection of population-of-origin specific Y chromosomal single nucleotide polymorphisms (Y-SNPs), mitochondrial (mtSNPs), or autosomal SNPs. Y chromosomal SNPs (Y-SNPs) are increasingly becoming important due to their paternal inheritance, lack of recombination, abundance, and low mutation rate and have been investigated for use in determining population structure. Potential forensic applications of Y-SNPs include their use in predicting the ethnogeographic origin of the donor of a crime scene sample, inclusion, or exclusion of suspects of sexual assaults (the evidence of which often comprises male/female mixtures and may involve multiple perpetrators), paternity testing, and identification of non- and half-siblings. Currently, many of the well characterized Y SNP markers do not differentiate between the large distributions of individuals belonging to the more common haplogroups such as the major European, African, and Asian derived haplogroups R1b3, E3a, and O. Additionally, more diverse populations, such as the Hispanic/Latin groups cannot be differentiated with the only current set of well defined Y-SNPs. The use of several recently phylogenetically defined Y-SNP markers that have the ability to differentiate between sub-populations within common Y-SNP haplogroups, and the use of mtSNPs and autosomal SNPs that can assist in distinguishing between many European, African, Asian, and Hispanic/Latin individuals within particular admixed haplogroups are reported here.

During the course of this study M222, a sub-R1b3 marker rarely used, and found several individuals that possess this polymorphism and also possess Y-STR haplotypes identical or derived from the 17 marker Irish Modal Haplotype (IMH) described by Moore et al were evaluated. Since IMH and IMH-1 individuals possess almost identical STR haplotypes, it is necessary to choose more informative STRs for individual identification of individuals within this haplogroup. How it is possible to replace a battery of Y-STRs with a certain Y-SNP, such as M222, allowing only the most discriminating STRs to be analyzed for individual identification of individuals within a particular haplogroup will be shown.

Several SNP genotyping methods are available, but many do not allow high-throughput multiplexing or are not sensitive. Pyrosequencing is a sensitive and reliable method that can be useful when a hierarchical multiplexing strategy is used. Pyrosequencing can consistently detect picogram quantities of DNA with a nested PCR amplification approach. The development of a sensitive, hierarchical multiplex system for use with pyrosequencing technology, incorporating the most informative Y-SNPs and enhancing their potential to discriminate between sub-populations by including mtSNPs and an ancestry informative autosomal SNP will be described.

Y-SNPs, Y Chromosomal Haplogroups, Pyrosequencing

B26 A Custom Relational Database Application to Assist in the Interpretation of Novel mtDNA Sequence Variation

Kimberly A. Sturk, MFS, Jodi A. Irwin, MS, Jennifer E. O'Callaghan, MFS, Jessica L. Saunter, BS, and Michael D. Coble, PhD, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Building 101, Rockville, MD 20850; and Thomas J. Parsons, PhD, International Commission on Missing Persons, Alipasina 45 A, Sarajevo, 71000, Bosnia and Herzegovina*

After attending this presentation, attendees will be familiar with a bioinformatics tool that assists in the interpretation of complex mtDNA sequence variation and have a greater appreciation for the extreme variability of the mtDNA control region.

This presentation will impact the forensic community and/or humanity by highlighting the importance of consistent nomenclature for mtDNA forensic evidence and presenting a tool in which to maintain this necessary consistency.

The use of mitochondrial DNA typing in forensic investigations is dependent on the comparison of a questioned haplotype to specific reference databases. Differences from the rCRS¹, as determined by alignment of the unknown sequence to the reference sequence, are queried against population databases in order to determine the relative rarity of the questioned haplotype. It is not uncommon, however, to encounter unusual variants that can be aligned to the rCRS in multiple ways. This can result in identical sequences being interpreted differently, and can ultimately lead to skewed database comparisons, if the alignment and/or nomenclature of specific motifs differs between the unknown sample and the reference database.

Given the frequent occurrence of unusual variants, the Armed Forces DNA Identification Laboratory (AFDIL) has developed an Access-based sequence calling guide to establish consistent nomenclature for internal population database and casework samples. Most of the nomenclature for the unusual variants included in the guide follows published recommendations for the placement of insertions and deletions (indels).^{2,3} However, new sequence variations that cannot easily be interpreted with published guidelines are regularly encountered. Thus, additional specific guidelines for motifs such as these have also been included.

The application-based calling guide catalogs previously observed sequence variants and organizes them by region (HVI, HVII, HVIII, etc.). The information is accessed through a graphical user interface (GUI) that presents various options to the users. These menu options provide the user with multiple ways to search the database and provide links to various help documents that describe nomenclature standards and database usage. In general, a user would reference the calling guide with a questioned motif in hand and then search specifically for information that would provide nomenclature guidance for that sequence. The user can decide to search the entire database, or can select a specific region (HVI, HVII, etc.) in which to focus the query. If the user elects to search a region, the application will return all unusual motifs previously observed in that region. Motifs or sequences that best represent the mtDNA variation in the questioned sample can then be identified. In addition, the guide offers a unique search feature that accepts simple text strings and returns the most appropriate nomenclature for the submitted motif. This tool filters through hundreds of potential calls and expedites the search for similar sequences. In all cases, electropherograms are linked to the records/motifs so that users can directly compare the raw sequence data from their questioned sample to the examples in the database. The database also tracks alternative calls that are in use by other laboratories so that potential nomenclature discrepancies can be easily identified.

The AFDIL Sequence Calling Guide is used regularly in practice. It is an additional tool that can be referenced to eliminate the subjective alignment of sequence data and establish greater consistency in the interpretation of unusual sequence variation.

The opinions and assertions contained herein are solely those of the authors and are not to be construed as official or as views of the United States Department of Defense or the United States Department of the Army.

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Mitochondrial DNA, Nomenclature, Sequence Alignment

B27 A Rapid and Simple Elution Method of DNA From Whatman® FTA® Classic Cards

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After attending this presentation, attendees will understand how 1.2mm FTA® punch disc is used for direct amplification using ABI Identifiler™ in the Singapore National DNA Database Laboratory. A rapid, inexpensive, and simple elution method was developed to elute DNA from the FTA punch disc so that amplification volume of 10ul or less can be achieved.

This presentation will impact the forensic community and/or humanity by demonstrating how 1.2 mm FTA™ punch disc is used for direct amplification using ABI Identifiler™ in the Singapore National DNA Database Laboratory. A rapid, inexpensive, and simple elution method was developed to elute DNA from the FTA™ punch disc so that amplification volume of 10 ul or less can be achieved. This method of elution will benefit the forensic community in being informed of a simple, cost-effective, and rapid methodology to elute DNA from FTA™ classic cards.

The Singapore National DNA Database Laboratory performs DNA typing using ABI® Identifiler™ through direct amplification on 1.2 mm FTA® punch disc. FTA® punch discs are washed using the Beckman Coulter® Biomek® 2000 robotic workstation on 96-well PCR plates and dried in oven before the amplification reagents are added.

Using direct amplification on 1.2 mm punch discs results in amplification failures when amplification volumes of 10 ml or less are attempted. Isolation of DNA from FTA™ cards can be achieved by extraction techniques using organic extraction or commercial DNA extraction kits. Alternatively, alkaline conditions or use of restriction enzymes such as Pst I can be used to elute the DNA. However, with the exception of the use of alkali, these methods previously described are both costly and require long incubation time.

Described here is an inexpensive, rapid, and simple method to elute DNA sufficient for DNA typing. Briefly, 10 ml of deionized water are added onto two 1.2 mm FTA® punch discs that have been washed and dried in each well in the PCR plate. The PCR plate is then sealed and heated for 95°C for 10 minutes, flash vortex, and centrifuged at 3000 rpm for 15 minutes. 3.5 ml of the FTA® eluate from the PCR plate is added to a PCR plate, pre-aliquoted with 4 ml of Identifiler™ PCR master-mix on the Beckman Coulter® Biomek® 2000 robotic workstation, sealed before amplification using 28 PCR cycles.

Using this method of elution, the DNA concentration estimated using ABI® Quantiblot® is approximately 0.48 ng/ml with the average total yield about 3.84 ng, which is optimal for amplification using Identifiler™. Out of the 82 samples genotyped using the ABI 3100 Genetic Analyzer, 81 returned a full DNA profile with the exception of one which returned a partial profile and required a re-injection using a higher voltage in order to obtain a full DNA profile. Full concordance was returned when the DNA profiles were compared to direct amplification of FTA® punch approach.

In conclusion, the elution of DNA from FTA® punch discs allows the amplification volume to be amendable to smaller PCR volumes of 10 ml and below. Excess DNA from the FTA® eluate can also be stored and used for other DNA analysis work without processing additional FTA® punches.

FTA™ Cards, DNA Database, Forensic DNA

B28 Evaluation of the Use of AmpF/STR® Identifiler™ STR Loci for the Inference of Ethnic Origins of Forensic Unknown DNA Profiles in Singapore

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After attending this presentation, attendees will have learned about the value of using the variations among the allele frequencies of each ethnic group to infer the ethnic origin of an unknown Identifiler™ developed DNA profile recovered from a crime scene.

This presentation will impact the forensic community and/or humanity by demonstrating the strengths and weaknesses of using the STR frequencies of Identifiler™ DNA markers to predict the ethnic origin of a given DNA profile, the accuracy of this method of inferring ethnic origin, and how this additional information can be useful in providing investigative leads for law enforcement agencies.

Singapore is a multi-ethnic country consisting of mainly Chinese, Malays, and Indians. Historically, these three major populations are migrants from the coastal regions of South China, the Malayan archipelago and South India more than two centuries ago. Based on the population database, it was observed that there are some unique and distinct differences in the STR allele frequency distribution between the three ethnic groups. By studying these dissimilarities, the laboratory has written a simple Excel® spreadsheet to predict the ethnic group of unknown forensic DNA profiles.

This presentation will impact the forensic community and/or provide humanity by demonstrating the possibility of inferring the ethnic origin of an unknown DNA profile using Identifiler™ STR allele frequencies.

The program was written based on two simple assumptions. Firstly, there is an unequal distribution of allele frequencies among the three populations in a few if not all loci. Hence, for an unknown DNA profile, different random match frequencies (RMF) will be obtained when using different ethnic population databases. Secondly, a large proportion within each ethnic population will have common alleles in a few if not all loci. Hence a DNA profile developed from a Chinese will yield the lowest RMF when using a Chinese population database compared to Malay or Indian database since the alleles encountered are more common in the Chinese population. With these understandings in mind, the laboratory has assumed that an unknown DNA profile always possess the highest composition of common alleles to its actual ethnic groups. Hence whichever population database gives the lowest RMF, the more probable the unknown DNA profiles belong to that ethnic group.

An Excel® spreadsheet was written based on the Identifiler™ STR loci allele frequencies of 500 individuals from the three ethnic groups. The function of the spreadsheet is to calculate the RMF for DNA profiles of unknown origin and to rank them accordingly; the database that gives the lowest RMF, the more likely that ethnic group it is. Testing of the excel spreadsheet was carried out with 200 DNA profiles from each ethnic groups. It has shown that the correct ethnic group is being inferred 58.8%, 70.9%, and 82.5% of the time for Malays, Chinese, and Indians respectively.

This in-house Excel® spreadsheet demonstrates the possibility of using Identifiler™ developed STR data to infer the most likely ethnicity of the DNA profile and to furnish such information to law enforcement agencies to serve as a potential investigation lead.

Ethnic Origin, Identifiler™, Random Match Frequency

B29 The Use of a Mitochondrial DNA-Specific qPCR Assay to Assess Degradation and Inhibition

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The goal of this poster presentation is to describe the utility of a mitochondrial DNA-specific quantitative PCR (mito-qPCR) assay in the forensic setting. This presentation will demonstrate how this assay was utilized at the Armed Forces DNA Identification Laboratory's (AFDIL) Research Section to quantitate mitochondrial DNA. The attendee will learn about qPCR as it relates to sample inhibition and/or degradation as well as how information from the assay is used for downstream assays other than traditional STR analyses.

This presentation will impact the forensic community and/or humanity by informing the forensic community of a variety of different uses for a mitochondrial qPCR assay as well as how laboratories could make use of the changes observed in the assay's internal PCR control cycle threshold (IPCCt) to assess the inhibitors present in a sample and different amplicon sizes to detect sample degradation.

Forensic DNA typing systems, including mitochondrial DNA analysis, allow the routine processing of many different samples types. Downstream assays such as short tandem repeat (STR) analyses require precise quantities of input DNA (0.5 to 2ng) in order to achieve optimal results, or profiles. Traditionally, slot-blot hybridization assays have been used to quantitate the amount of nuclear DNA in forensic samples. This method, though sensitive and human-specific, is time-consuming, labor-intensive, and not readily amenable to automation. More recently, quantitative PCR (qPCR), in which the amplification of specific target sequences is measured in real-time, has become a popular choice for forensic DNA quantitation. The production of a commercial kit containing all of the components necessary to run the assay has made it readily available to forensic labs requiring extensive validation of such protocols. Additional assays recently published in the forensic literature have also been developed that target human nuclear DNA, the human Y chromosome, and the human mitochondrial genome.

Although the downstream analysis of mitochondrial DNA, i.e. cycle sequencing, does not have the same requirements as STR assays regarding input DNA quantity, other information provided by a qPCR assay can be useful for analysis. For example, some qPCR assays include an IPCCt to assess inhibition in the extracts tested. Variation in the IPCCt of a sample in comparison to that of the non-template controls

(NTC) would indicate a potential inhibitor present in that sample. Since the quantitation is performed using the same mechanism as the downstream assay, that is, the polymerase chain reaction, the results of the qPCR assay mimic the extract's amplification behavior in the downstream assay. Therefore, if inhibition is detected during quantitation, additional measures such as further purification and/or dilution can be employed to allow successful subsequent PCR amplification and sequencing. Similarly, the successful quantification of target amplicons of different sizes can be used to assess a sample's state of degradation and to determine whether mini-primer sets should be employed for amplification.

The AFDIL Research Section is continuously evaluating new extraction protocols as well as producing large mitochondrial control region databases. A mito-qPCR assay would be useful in evaluating the success of these new extraction procedures as well as predicting the success of the sequencing of database samples. The authors have utilized an in-house mito-qPCR assay developed by the Institute of Legal Medicine (Innsbruck, Austria), which was based upon the duplex nuclear-mito qPCR assay described by Andreasson, et al. (2002). This assay employs three different target amplicon sizes to allow for the assessment of the level of degradation of a sample, as well as an IPC to assess any potential inhibitors present in the extract. In this poster the authors will present a variety of uses for this mitochondrial qPCR assay, the changes observed in the assay's IPC Ct as it relates to the inhibitors present in a sample, and the detection of sample degradation. These parameters will be related to the samples' performance in the selected downstream application, in this case, PCR amplification, and cycle sequencing.

The opinions and assertions contained herein are solely those of the authors and are not to be construed as official or as views of the United States Department of Defense or the United States Department of the Army.

Reference:

Andreasson H, Gyllensten U, Allen M. Real-time DNA quantification of nuclear and mitochondrial DNA in forensic analysis. *Biotechniques*. 2002 Aug;33(2):402-4, 407-11.

Quantitative PCR, Mitochondrial DNA, Inhibition

B30 The Impact of Whole Genome Amplification on Forensic Testing

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The goal of this presentation is to educate investigators and analysts about the applicability of isothermal whole genome amplification methods to obtain usable DNA from previously inaccessible samples. Data will be presented on getting usable STR profiles from compromised DNA.

This presentation will impact the forensic community and/or humanity by outlining the adoption of whole genome amplification methods into standard forensic investigation process. Data will be presented.

Introduction: The availability of DNA from trace samples can be limited. A reliable technology capable of accurate replication of high-quality genomic DNA from limited samples enabling reliable STR typing is required. The replicated DNA must be identical to the original genomic DNA template and ideally replication of genomic DNA should also be possible directly from the forensic sample without extraction of DNA.

Much effort has been invested by forensic scientists in the optimization of PCR-based generic amplification methods for genomic DNA amplification such as degenerate oligonucleotide-primed PCR

(DOP-PCR) or primer extension preamplification (PEP). However, these PCR-based methods generate non-specific amplification artifacts and give incomplete coverage of loci.

The use of QIAGEN's REPLI-g technology for forensic identity testing, utilizing a novel method for whole genome amplification (WGA) termed multiple displacement amplification (MDA) is described. This technique is capable of accurate in vitro DNA replication of whole genomes, without sequence bias, yielding DNA suitable for direct use in STR typing.

Normalized yields from a variety of samples: Various samples can be used in a REPLI-g MDA reaction, including purified genomic DNA and fresh or dried blood. Typical DNA yields from a REPLI-g Mini Kit in vitro DNA replication reaction are approximately 10 µg per 50 µl reaction. A uniform concentration of amplified DNA is usually achieved regardless of the quantity of template DNA (Figure 2). Obtaining uniform DNA yields from varying template concentrations is particularly important for STR typing applications, enabling subsequent analysis without the need to measure or adjust DNA concentration. The average product length is typically greater than 10 kb, with a range between 2 kb and 100 kb (Figure 3).

Whole Genome Amplification (WGA) of human mitochondrial DNA: A single mitochondrion contains several copies of mtDNA and each cell in the human body contains hundreds to thousands of mitochondria. This effectively means that there are hundreds to thousands of mtDNA copies in a human cell compared to just 2 copies of nuclear DNA located in that same cell. Thus, forensic scientists make use of enhanced sensitivity by characterization of mtDNA in situations where nuclear DNA is significantly degraded, or present in very small quantities.

In situations where a reference sample cannot be obtained (e.g., from a long deceased or missing individual), a mtDNA reference sample can be obtained from any maternal relation.

The newly developed REPLI-mt Kit contains DNA polymerase, buffers, and reagents for whole genome amplification from small samples of human mitochondria genome using multiple displacement amplification (MDA). The technology allows uniform amplification of the whole mitochondrial genome with minimal nuclear DNA contamination. Typical DNA yields are approximately 5 µg per 50 µl reaction.

Method: The REPLI-g MDA method is an isothermal genome amplification utilizing a uniquely processive DNA polymerase capable of replicating 100 kb without dissociating from the genomic DNA template (Figure 1). The DNA polymerase has a 3' to 5' exonuclease proofreading activity to maintain high fidelity during replication and is used in the presence of exonuclease-resistant primers to achieve high yields of DNA product. In addition, the REPLI-g amplification enzyme is significantly more tolerant against inhibition than Taq DNA polymerase.

Two novel technologies have been developed for the amplification of highly compromised material and for specific amplification and enrichment of human mitochondrial DNA. Genomic DNA becomes damaged on exposure to the environment, as is often the case with crime scene samples. mtDNA analysis is applied in forensic science to enhance sensitivity in situations where nuclear DNA is significantly degraded or where insufficient quantity is available. The application of these new WGA techniques will further enhance the usefulness of WGA to forensic sciences.

Minimum sequence bias: PCR-based methods (e.g., DOP-PCR and PEP) generate nonspecific amplification artifacts, give incomplete coverage of loci, and generate DNA fragments significantly less than 1 kb long that will lead to reduced amplification success and poor results when using large STR amplicons. In contrast, REPLI-g provides highly uniform amplification across the entire genome, with no sequence bias.

Amplification of fragmented or damaged DNA
Biological samples exposed to the environment often yield compromised DNA. The degree of DNA damage depends on a number of factors, including environmental conditions such as UV irradiation, pH, and the method of sample processing prior to DNA isolation (e.g.,

homogenization). Different types of DNA damage can occur; the most prominent being chemical or enzyme-induced fragmentation.

The novel REPLI-g damaged DNA technology allows whole genome amplification of fragmented or otherwise damaged DNA previously isolated from biological samples. It enables highly uniform amplification across the entire genome (depending of the degree of damaging) and is suitable for use with DNA >_ 300 bp in size. REPLI-g damaged DNA amplification is a two step process: an initial processing reaction preparing the damaged DNA for whole genome amplification and a second amplification reaction.

Whole Genome Amplification, Low Copy Number, Casework Evidence

B31 Next Generation Expert System for STR Analysis and Review

Jaime J. Handelsman, BHS, Ravi Gupta, MS, Lisa M. Calandro, MPH, and Thomas J. McElroy, Applied Biosystems, 850 Lincoln Centre Drive, Foster City, CA 94404*

After attending this presentation, attendees will understand an improved expert system that will significantly minimize STR analysis and review.

Data analysis and review of STR profiles is a bottleneck for many casework and databasing labs around the world. This presentation will impact the forensic community and/or humanity by providing an expert system that will not only analyze and score profiles more robustly but provide the user the tools to more efficiently and quickly isolate the data that requires manual review as defined by user settings.

The next generation GeneMapper® ID Software is designed specifically as an expert system for the analysis of data generated from AmpFISTR® kits to meet the demands of human identification applications, including forensic casework, the generation of convicted offender and population databases, parentage testing, tracking specimens, and identifying missing persons, military personnel and mass disaster remains. The software combines precision-sizing capabilities with reliable allele-calling ability into one intuitive piece of software. This presentation will describe key new features that will provide users with the tools and confidence to review and process data more quickly and efficiently than before. New features include:

- Multi-user database access to allow labs of all sizes to more easily access, process and manage their data. Examples of ways that laboratories can utilize this functionality to streamline their current workflow will be shown.
- E-signature, security, and audit trail functionality will help address chain of custody needs by providing users the ability to better track changes and control data analysis and data access within a lab.
- Novel Process Component Based Quality Values (PQVs) have been expanded. These PQV's are easy to use flags that enable a user to quickly segregate the specific data components that require troubleshooting from data that can be confidently and efficiently passed without further review.
- Improved data viewing functionalities which are designed to minimize the data review process and significantly improve the analysis workflow.

The presentation will highlight the validation of the GeneMapper® ID Expert Systems Software for use with validated ABI PRISM® Genetic Analysis instruments as an expert system for single source sample analysis and for the analysis of a range of casework sample types.

Expert System, Data Analysis, GeneMapper®

B32 2005 Census of Crime Laboratories

Joseph L. Peterson, DCrim, Dennis Longmire, PhD, Steven Cuvelier, PhD, Anna Leggett, BS, and Robert Morris, MS, Criminal Justice Center, Sam Houston State University, Box 2296, Huntsville, TX 77341; and Matthew Hickman, PhD, Bureau of Justice Statistics, 810 Seventh St., NW, Washington, DC 20531*

After attending this presentation, attendees will become familiar with the data gathered in the 2005 Census of Crime Laboratories, including the success of survey methods and information describing the functions, staffing, budget, workload, backlogs, and resource needs of the surveyed laboratories.

This presentation will impact the forensic community and/or humanity by updating data contained in the 2002 Census and will help to set crime laboratory management and funding priorities for public agencies nationwide.

Outcome: The information in this presentation updates data contained in the 2002 Census and will help to set crime laboratory management and funding priorities for public agencies nationwide.

Sam Houston State University, in cooperation with the American Society of Crime Laboratory Directors (ASCLD) and the National Forensic Science Technology Center (NFSTC), conducted the 2005 Census of Publicly Funded Crime Laboratories, with grant support of the U.S. Bureau of Justice Statistics. The 2005 Census was administered to 393 public crime laboratories and gathered information on the functions, personnel, expenditures, workload, backlog, and resource needs of crime laboratories nationwide. This new census updates and builds upon the 2002 Census of Crime Laboratories that found backlogs of requests requiring scientific analysis jumped from 290,000 requests to more than 500,000 requests. Other principal findings in the 2002 Census included:

- The nation's crime laboratories employed more than 9,000 FTE personnel and had budgets totaling more than \$750 million.
- Laboratories received more than 2.7 million requests for services and were able to process just under 2.5 million of them by yearend.
- Controlled substances constituted half of all laboratory requests, followed by toxicological and latent print analyses.
- DNA requests, although making up just 2% of new requests, are an area where backlog was increasing fastest – for every five requests completed, about six requests remained outstanding at yearend.
- Labs estimated that \$70 million in new personnel costs and about \$500 million for renovated and larger facilities, new instrumentation, and equipment were needed to achieve 30-day turnaround times on requests.

The new 2005 Census was significant in that it employed new survey technology allowing crime laboratories to use a CD to transmit their information electronically to the project's data base server at Sam Houston State University. Laboratories could also submit their data by logging onto the project's Internet site, or by submitting their paper survey through conventional mail. Technical assistance was also offered to crime laboratories in completing their surveys by staff at Sam Houston State and by a group of ASCLD and NFSTC advisors. The goal of the project was to achieve a 100% response rate from identified laboratories.

The 2005 Census updates all information items gathered in the 2002 survey. The new Census is also important in that it asks additional information about laboratories' use of data bases (CODIS, NIBIN, and AFIS), the status of their information management systems, a more detailed breakdown of the costs of new equipment needed by disciplinary area, added information about types of DNA casework and databasing requests, the internal and external costs for outsourcing DNA casework and CODIS data-basing, controlled substances and toxicology, and added detail about peer review activities. Additional open-ended

questions asked about innovative programs used by laboratories to manage casework, and improvements made to the physical structure of laboratories in recent years.

Data collection and analysis continues through calendar year 2006, and updated information will be presented at the 2007 Annual Meeting.

Census, Survey, Crime Laboratories

B33 Building a New Crime Laboratory Facility With Strategic Partnerships

Barry A.J. Fisher, MS, MBA, Los Angeles County Sheriff's Crime Laboratory, 2020 West Beverly Boulevard, Los Angeles, CA 90057*

The goal of this presentation is to provide new insights how different agencies can work together for the benefit of all. It is an example of the saying: the sum of the parts is greater than the individual components.

This presentation will impact the forensic community and/or humanity by demonstrating how even in difficult economic times, major funds to construct a new lab can be obtained. They will also learn how partnering with neighboring agencies can create a new and vital forensic science service delivery system.

Finding ways to finance a new crime laboratory is challenging even in the best of circumstances. When budgets are tight, finding sources of funding can become a near impossibility. This presentation describes a novel way this problem was solved in Los Angeles through strategic partnerships and political acumen.

By the early 1990s, the Los Angeles County Sheriff's Department (LASD) faced chronic overcrowding in the laboratory along with a classic case of so-called "sick building syndrome." When LASD moved into the current facility in the mid 1970s, the lab was only supposed to be there for a couple of years while funding would be found for a new facility. Twenty five years later, the facility was no longer doing the job for us. Major systems were failing and the staff was becoming increasingly unhappy with crowded working conditions.

Inadequate work space is an insidious problem. It's very easy to get used to inadequate workspace and accept that reality as the way things are meant to be. However, productivity and employee morale begins to suffer. Often, by the time laboratory management recognizes the need to act; overcrowding goes from being a small problem into a serious issue.

LASD took these problems to the county's Board of Supervisors in 1994 but because of the costs associated with building a new facility, a decision was made to wait for better economic times. Later, LASD was able to fund a needs assessment by engaging a local architectural firm which brought in considerable crime laboratory experience. That study became the basis of the future project. Through that process, the lab learned an important lesson: building crime labs is as much a political issue as a public safety issue. LASD also learned that selling the idea for a new lab was the key. The lab had to learn how to market!

Los Angeles is home to two large metropolitan crime laboratories operated by the LAPD and the LASD. As it turned out, both needed new facilities and both were having problems finding funds. The key to the project was capturing the interest of local political leaders who recognized the unique collaboration forged as a strategic partnership between the LASD and LAPD crime labs, a local university offering a MS degree in Criminalistics – California State University, Los Angeles (CSULA), the CA DOJ California Criminalists Institute and a new created California Forensic Science Institute at CSULA.

The vision that was presented was an extraordinary partnership between the city and county of Los Angeles, and the State of California. That vision was articulated by the sheriff who was able to persuade the state to fund the project at nearly \$100M. The project is under construction and occupancy is expected in early 2007.

Building a New Crime Lab, Funding Strategies for Lab Construction, Forensic Synergy

B34 Crime Scene Search Theory

H. Dale Nute, PhD, and Mark A. Feulner, MA, Florida State University, Panama City, 4750 Collegiate Drive, Panama City, FL 32405*

After attending this presentation, attendees will increase understanding of the factors involved in a complex crime scene search.

This presentation will impact the forensic community and/or humanity by providing an awareness of a theoretical basis for crime scene search.

The discipline of crime scene investigation (CSI) like the rest of forensic science has focused predominately on technology rather than theory. For the most part this has worked; however, there are indications that changes are becoming necessary. Some thought process is needed rather than just "do what worked last time." In this vein, a theory for crime scene search is explored.

Search theory was worked out fairly extensively for naval purposes in World War II and subsequently applied to marine search-and-rescue (SAR) operations. The marine SAR procedures are currently being expanded for land SAR operations in remote, rural areas. The SAR procedures could also be adapted for evidential searches. Some suggestions for making these adaptations are advanced in this presentation.

Breaking the search down into its parts allows each to be examined for improvement. This analysis includes both the theoretical components and the technological methodology. A crime scene search begins with the theory: A crime is the intersection of a criminal with his target in time and space. The crime scene is obviously the space but the evidence in that space is determined by the impacts of the criminal, the victim, and the time of occurrence against what was there, i.e., the changes in the scene. In order to get the most from a crime scene search, the crime scene investigator must make a time-space-psyche analysis. Such an analysis combines the art of the investigator and the craft of the scientist and focuses on three factors – Purpose, Probability, and Procedures.

The Purpose has two aspects – to reconstruct what happened, when, where, and how; and to associate the culpable individual with the event, if not its cause. Reconstruction depends on the type of crime as that determines what information is required and thus what types of evidence needs to be located to provide that information. Association depends more on locating and evaluating materials that originate from any individual that had means, motive, and opportunity.

Probability also has two aspects – the probability that the evidence of interest is in a particular location; and the probability that it will be found in that location with a particular search methodology. The first is based on applying investigative information and the second is based on error analyses of the various search methodologies under the particular conditions of the search area.

The Procedures are of two types – those for calculating the probabilities and those for executing the search. The probability calculations are based on subjective information but still need to be methodical. Investigative probability calculations are based on knowledge of people and how they act in various situations. Search methodology probability calculations are based on protocol development. The search procedures include techniques for controlling the search and methods for detecting the evidence during the search. Both are highly situation dependent and the variety of situations requires a range of protocols. Based on the replicate testing used when developing the protocols, one can calculate the probabilities used both to make decisions about managing the search and for evaluating the results.

Crime Scene, Search Theory, Probability

B35 Developing Investigative Leads Through Trace Evidence

Samuel J. Palenik, and Christopher S. Palenik, PhD, Microtrace, 1750 Grandstand Place, Elgin, IL 60123-4900*

After attending this presentation, attendees will learn how the application of advanced trace evidence techniques can provide investigative leads to cold cases, fresh cases and cases with limited amounts of evidence.

This presentation will impact the forensic community and/or humanity by demonstrating the formulation of investigative leads through trace evidence in criminal investigation has a history of lore in both historical examples and Sherlockian fiction, but it is rarely, or at best, sporadically employed to the benefit of cold cases and is almost never applied to fresh investigations when trace evidence is most readily available. It is hoped that the examples presented here will provide both scientists and investigators with a renewed appreciation of the information and benefits that trace evidence can provide in an investigative examination.

While part of this can be ascribed to financial constraints and the reliance placed on DNA evidence, probably the largest reason can be attributed to the fact that investigators are not necessarily aware of the information that can be extracted from trace evidence. Furthermore, the extents to which an analysis of trace evidence can be taken by an analyst, or the depth of interpretive information that can be extracted from the sum of available evidence is not necessarily encouraged by the segmented design of many forensic laboratories in which scientists are permitted or certified to analyze only a particular category of evidence.

As opposed to the more familiar comparative type cases in which known and questioned evidence must be associated, a case requiring the development of investigative leads typically has no suspect and often has limited “unknown” evidence. In these cases, a scientist is required to develop testable hypothesis as to the origin of any evidence that has been recovered. These hypotheses take the form of descriptive postulations about the sought-after suspect, their environment, and their history. In these examinations, the freedom for an investigating scientist to be allowed to interrogate and integrate all available evidence is critical, as is a required familiarity with these materials, particularly because of the small amount of sample often available. These materials can include, among other items, hair, fibers, paint, rubber, soil, industrial dust, pollen, and other botanical matter. Equally important to the identification of these materials is the continued analysis that provides further differentiation. For example, if calcite is located, in what environment did it form? Was it formed as a marble, a detrital mineral, in an evaporate environment, or as a pigment/filler? A solid familiarity with materials will allow the identification of a certain particle to be further specified to a particular end-use. It is only by taking an identification beyond the preliminary recognition of an item as “paint” or “wood” and further characterizing it as an “Ford automotive paint” or a “sugar maple – *acer saccharum*” that the reason a particular particle of evidence may be relevant.

These and other approaches towards the production of evidentiary leads will be illustrated through various cases in which trace evidence has provided investigators with actual leads that have lead to consequential arrests, confessions and convictions. Each of these examples will be illustrated by explaining the background information provided to us, the analytical approaches utilized, and most importantly, the way in which the evidence identified was interpreted to provide investigators with a picture of relevant events and processes. All of these cases will illustrate the importance of all-inclusive analyses that violate the traditionally established scientific disciplines. It is hoped that these examples will provide both scientists and investigators with a renewed appreciation of the information and benefits that trace evidence can provide in an investigative examination.

Investigative Leads, Microscopy, Trace Evidence

B36 Global Forensic Provenancing With Geochemical Methods

Jurian A. Hoogewerff, PhD, School of Chemistry and Pharmacy, University of East Anglia, Norwich, Norfolk NR4 7TJ, United Kingdom*

After attending this presentation, attendees will learn about the new developments in geographical provenancing and be informed about the possible applicability and limits.

This presentation will impact the forensic community and/or humanity by showing the forensic community that state of the art in forensic provenancing is aiming at a new level of sophistication by combining global information from several disciplines in one expert system. The presentation will provide policy makers with information about the state of present research and case experts in the field with new possibilities to get valuable information in complex cases.

Due to the globalization of legal (and illegal) trade and the limits of paper/electronic mandatory or voluntary traceability systems there is an increasing demand for techniques which can verify and/or validate the geographical origin of commodities. Not only is this relevant for consumer confidence but in almost every case where the origin and/or quality is questioned there is interest to have an independent method able to verify claimed origin.

Provenancing of raw food products like mineral water, vegetables, fruits and shellfish and processed products like honey, wine and olive oil have a high feasibility for geographic profiling as these items have a strong geochemical relation with the host rock and/or soil and precipitation. As certain rock and soil types have a limited spatial distribution on earth, the chemical signature the products inherit from their geochemical and/or bio-climatic environment, may enable geographical sourcing.

The bio-geo-chemical Natural Isotope and Trace Element (NITE) signatures consist of elemental and isotopic profiles related to regional climate (H and O isotopes), bio-environment (C and N isotopes) and geology (elements and S, Sr, Nd, Pb and other isotope systems).

A very important aspect of sourcing is the validation method. The most commonly suggested, but often prohibitively expensive, method is the construction of an analytical database based on authentic samples from specific areas which needs to be maintained indefinitely. More problematic is that any item from an un-authenticated area might lead to false positives. The second method, expensive only in its implementation phase, is to develop an understanding of the relation between the NITE profile in a certain product and its geo-bio-climatic environment. The latter method has the advantage that often knowledge about the geo-bio-climatic environment of un-authenticated area is available, e.g. D/H and ¹⁸O isotope precipitation maps, geological and geochemical maps.

However the development and implementation of geo-bio-climatic profiling requires extremely robust analytical methodology and a continued commitment to a very high level of quality assurance.

Against this background the EU has funded a €19M research project TRACE to develop geo-bio-climatic analytical specifications of origin to be combined in a general traceability system. The project will investigate in detail if geo-bio-climatic profiles from a set of food commodities with different grades of complexity: mineral water, wheat, olive oil, honey and lamb meat from 20 different 10x10 km test sites in Europe, can be linked to the geo-bio-climatic environment at these sites. The NITE profiles from soil digests and extracts and local water will be compared with NITE profiles of the selected commodities. On selected commodities additional compound, genetic and pollen analysis will also be performed. The gathered data, combined with full paper/electronic paper traceability data, will be used as initial training set for a Geographical Information System (GIS) based knowledge system. Subsequently the system will be tested on world wide validation sample set. Once the knowledge system is validated it is aimed to be used by the EU to routinely screen food commodities from possible questioned origin before embarking on a full forensic investigation.

The TRACE project also investigates the possibility to include geo-bio-climatic profile data on the product label in a sophisticated bar-code type manner, a chemometric passport for foodstuffs, in the anticipation of the desire for much stronger traceability validation/verification in EU (import) legislation (www.trace.eu.org).

Although at present the focus is on food, the method developed will be applied to other criminal forensic trace material like human remains and drugs.

At present, other TRACE-mirror initiatives are being set-up in Latin America, Australia and New Zealand, China and the USA to enable world wide geographical profiling by NITE and related methods.

Trace Evidence, Provenancing, Biosecurity

B37 Analysis of Forensic Soil Samples Via High Performance Liquid Chromatography and Ion Chromatography

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The goals of this presentation are to demonstrate the use of high performance liquid chromatography (HPLC) and ion chromatography (IC) to assess the qualitative and quantitative variation in these fractions of soil and to demonstrate spatial and temporal variation in soil and the importance of population sampling in soil analysis.

This presentation will impact the forensic community and/or humanity by showing how the use of these methods will decrease the number of type II errors in soil analysis and demonstrating the spatial and temporal variation will demonstrate the need for population sampling in soil analysis.

Traditional forensic soil comparisons are performed via physical and/or chemical examinations of color, texture, and mineral content, leaving any organic- or water-soluble fractions unexamined. This study uses high performance liquid chromatography (HPLC) and ion chromatography (IC) to assess the qualitative and quantitative variation in these fractions of soil.

Soil samples were collected over the course of three weeks from 120 locations in and around Lansing, MI and were designated as urban (n=40), suburban (n=40), or rural (n=40). Criteria used to categorize each area included the local human population, the amount of vehicle and pedestrian traffic, the distance from residential or commercial structures, and the general use of the land as commercial (urban), residential (suburban), or agricultural (rural). Additional samples from six of these locations (two urban, two suburban, and two rural) were collected once a week for ten weeks for temporal analysis. Nine additional samples, equally spaced over a 1 m² grid, from these same six locations, were collected for spatial analyses.

All samples were collected using a #9 soil plug to a depth of about 1" five times and stored in brown paper bags. Each sample was placed in a glass petri dish, dried in a 60°C oven for two hours, and sieved through a 60/250 mesh/micron Tyler certified brass sieve. The fraction that passed through the sieve was stored in a vial for analysis.

The Dionex HPLC system consisted of a P680 pump with an ASI-100 autosampler and UVD340U diode array detector. The columns used were a Phenomenex Widepore C18 guard column (4 mmL x 2 mmD) and an Alltech Widepore Econosphere C18 column (5 u particle size, 250 mm x 4.6 mm). Various combinations of extract concentrations, mobile phase compositions, and run times were tested to determine the optimal sample preparation method and system parameters to achieve sufficient peak resolution.

IC samples were run on a Dionex DX-120 ion chromatograph with a Dionex AS40 autosampler and electrochemical detector. Samples were analyzed on two different columns and by two separate methods. The first method utilized an IonPac AS9-HC (4 mm x 250 mm) column with a mobile phase of 9 mM Na₂CO₃ at a flow rate of 1.19 ml/min for 35 minutes and a 25 µl injection volume to detect and quantify nitrite, bromide, chlorate, nitrate, phosphate, and sulfate. The second method utilized an ASI16 (4 mm x 250 mm) column with a mobile phase of 35 mM NaOH at a flow rate of 1.19 ml/min for 35 minutes and a 25 µl injection volume to detect and quantitate perchlorate, thiosulfate, and chlorate.

All samples were prepared for IC analysis using no less than 0.5 g of sieved soil in a 0.5 g/ml solution in reagent grade water. This solution was sonicated for ten minutes and filtered through a 0.45 µm syringe filter (Pall) into two 0.5 ml IC autosampler vials.

Qualitative and quantitative analysis of the resultant chromatograms separated the 120 samples into 10 groups by HPLC and 23 groups by IC groups.

This study shows that using HPLC and IC to analyze the organic- and water-soluble fractions of soil can successfully discriminate samples. Including quantitative analysis of the results eliminates some false inclusions by providing further differentiation of samples. To demonstrate that the variation observed via HPLC and IC analysis is an independent variable from the inorganic composition, ten samples that were differentiated by these methods were examined via X-Ray fluorescence. Some of the samples were broadly similar in elemental composition in a one to one comparison. Although this comparison was not performed with a population of known samples, the XRF data indicates that additional discrimination is possible when HPLC and IC analysis are added to traditional forensic soil analysis schemes.

The methods used in this study were able to detect both qualitative and quantitative variations in soil over a relatively small geographic area. This demonstration of soil heterogeneity underscores the importance of the collection of a representative known sample population when assessing a forensic soil comparison. Significant temporal variation was also demonstrated over the course of ten weeks of sampling; however, samples were found to be consistent over shorter periods of time.

Baseline levels of inorganic anions were determined via IC; these levels may be useful in assessing the significance of anions detected in soil from cases involving low explosives.

* This work was funded by the National Institute of Justice, through the Midwest Forensics Resource Center at Ames Laboratory under interagency agreement number 2002-LP-R-083. The Ames Laboratory is operated for the U.S. Department of Energy by Iowa State University, under contract No. W-7405-Eng-82.

Soil Analysis, High Performance Liquid Chromatography, Ion Chromatography

B38 A Novel Approach to the Examination of Soil Evidence: Mineral Identification Using Infrared Microprobe Analysis

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After attending this presentation, attendees will gain an awareness of the application of infrared microspectroscopy for mineral identification, a vital aspect of soil evidence analysis.

This presentation will impact the forensic community and/or humanity by providing an innovative technique for mineral identification which will augment traditional methods of soil analysis.

Soil evidence is commonly encountered at a wide variety of crime scenes, and can be potentially very valuable because of its ability to identify and individualize. Despite this fact, soil analysis is underused and underappreciated in the forensic science community. Advances in the field of infrared microprobe analysis make it possible to perform rapid, reliable, and reviewable identifications of minerals found in soil samples.

The application of infrared microprobe analysis for fiber and paint-evidence analysis is well established and accepted in forensic science laboratories. With new advancements, infrared microprobe analysis can be extended to a wide range of physical evidence; from the identification of minerals and illicit drugs to the differentiation of glass evidence. This paper focuses on the use of the infrared microprobe for the identification of minerals in soil samples.

Infrared microprobe analysis of minerals is made possible through the use of the diamond attenuated total reflection (ATR) microscope objective. The design and use of the diamond ATR microscope objective allows for the selective isolation of individual minerals for simultaneous collection of microscopic, optical, and infrared data, thus enabling the indisputable identification of minerals. Infrared microprobe analysis requires virtually no sample preparation, and enables direct infrared spectroscopic analysis of unknown mineral samples. When coupled with a preliminary examination using traditional methods of polarized light microscopy, complete analysis of an unknown mineral can be performed quickly and easily. Thus a mineralogical profile of a soil sample can be obtained in a short time.

Prior to applying this technique to soil analysis, an infrared spectral library of approximately fifty common minerals was made and tested using the infrared microprobe. Notwithstanding the existence of thousands of diverse minerals, a single soil sample usually contains between three and five mineral varieties, with only twenty minerals being prevalent in all soils. Thus, a library containing the spectra of fifty minerals was deemed sufficient for forensic soil analysis. Next, soil samples were obtained and the mineral fractions separated using traditional methods. The minerals were then isolated, analyzed, and identified using the polarized light microscope and the infrared microprobe. This study shows the great benefits of infrared microprobe analysis for mineral identification and the rapid, reliable, and reviewable creation of a mineralogical profile of a soil sample. The ability to integrate polarized light microscopy with infrared microprobe analysis to minerals in soil samples is unprecedented.

Soil, Mineral, Infrared Microprobe

B39 Assessment of LA-ICP-MS for the Forensic Analysis of Soil and Sediments

Luis Arroyo, MSc, Piero R. Gardinali, PhD, José R. Almirall, PhD, and Tatiana Trejos, MSc, Florida International University, 11200 SW 8th Street, Chemistry Department CP 153, Miami, FL 33199*

After attending this presentation, attendees will understand the applicability of laser ablation ICP/MS as an alternative methodology for the elemental profile in complex matrices like soils and sediments. Avoidance of digestion procedures is a clear advantage of the proposed technique.

This presentation will impact the forensic community and/or humanity by demonstrating the use of a non-destructive technique for the elemental characterization of possible contaminated sites or to conduct a rapid screening of background levels in protected areas. In addition, this technique can also be applied for paired-comparison of samples to determine likely sources of origin in homicides, kidnapping and other crimes.

Forensic examination of soil and sediments are an important part of the services provided by forensic science laboratories since they are matrices frequently encountered in crime scenes. The investigation of these matrices has generated increasing attention within the environmental forensic arena. The value of the data obtained from such investigations will impact the legal processes and must be scientifically reliable and legally defensible. Several methodologies has been used for the evaluation of elemental profiles in this type of evidence such as X-Ray fluorescence (XRF), inductively coupled plasma mass spectrometry (ICP) and/or energy dispersive X-Ray (EDX).

The aim of this study is to develop, optimize, and validate a method for the analysis of soil and sediments by LA-ICP-MS in order to evaluate its utility to forensic analyses. As a primary goal, the proposed method can be applied to the analysis of environmental samples to monitor contaminated sites and/or to conduct rapid screening of background levels in protected areas. In addition, this technique can also be applied for paired-comparison of samples to determine likely sources of origin in homicides, kidnapping and other crimes.

The use of LA-ICP-MS for soil and sediments has several advantages over the conventional digestion methods, including direct characterization of solids with minimum handling and very low sample consumption (~ ng vs ~ mg of samples). Common multi-step dissolution procedures for these solid samples are avoided which represent a better alternative for faster analysis while still allowing the multi-elemental characterization of complex geological matrices. The key issue is to provide precision and accuracy comparable to traditional methods.

Three different ICP-MS instruments were used in standard operation modes in order to account for robustness of the method: HP-4500 (Agilent Technologies, Palo Alto, USA), ELAN DRCII (PerkinElmer LAS, Shelton CT USA), Element 2 (Thermo Electron GmbH, Bremen, Germany). Two different laser units were used for this work: 1) a *New Wave UP- 213* operating at 213 nm (New Wave Research, USA) and 2) a *CETAC LSX 500* (CETAC, USA) operating at 266 nm. A Scanning Electron Microscope with EDX detector (SEM/EDX) JSM-5900LV Jeol (JEOL, Japan) was used for the imaging of craters on soil standards and the determination of particle size distribution of the internal standard.

A critical evaluation of parameters of forensic interest is discussed in detail, including the analytical performance of the technique, homogeneity of the samples at microscale, reproducibility, use of matrix matched standards and quantification strategies.

Of the parameters controlled in the experiments, spot size, ablation pattern, sample grain size after homogenization, and the choice of the internal standard were found to be the key factors to improve the analytical performance of the method. Analytical results obtained by LA-ICP-MS were compared versus solution work followed by ICP-MS in terms of accuracy, precision and time of analysis.

The application of this novel method to environmental samples, particularly soil and sediments is evaluated. Soil and sediment standards were used for the optimization and evaluation of the analytical performance of the method. Two proficiency test samples were analyzed to validate the method. Good agreement with the participant laboratories on this round robin (using solution methods) was achieved, demonstrating the ability of this method for elemental analysis of these matrices. In addition, this method was applied to a set of real samples and the results are compared to data obtained by typical dissolution ICP-MS method.

The novelty of the proposed method relies on the application of laser ablation for the elemental analysis of soil and sediment matrices by ICP-MS using a single solid matrix matched standard with internal standardization for the quantification. The developed method uses solid standards without the need of using binders or liquid standards.

Laser Ablation ICP MS, Soil/Sediments, Elemental Analysis

B40 Micro-Homogeneity Studies of Trace Elements in Solid Matrices by LA-ICP-MS: Implications for Forensic Comparisons

Tatiana Trejos, MS, Benjamin Naes, BS, and José R. Almirall, PhD, Florida International University, 11200 SW 8th Street CP 194, Miami, FL 33199*

After attending this presentation, attendees will understand how to apply micro-homogeneity studies of trace elements in solid matrices such as glass, paint, and soil to define sampling strategies and interpretation of this type of evidence.

This presentation will impact the forensic community and/or humanity by provide forensic examiners with useful information to apply LA-ICP-MS methods for the elemental analysis of glass, paint and soil. During this presentation participants will learn advantages and disadvantages of conducting LA-ICP-MS analysis for these matrices. Microheterogeneity studies of these samples will assist forensic scientists in developing proper strategies for recovering, sampling, and interpreting the data.

Laser Ablation is a valuable tool for the direct solid sampling of trace evidence within the forensic context. Some of the advantages of LA sampling prior to ICP-MS analysis include elimination for the need of chemical procedures required for dissolution, reduced risk of contamination during the sample storage and sample preparation and vastly reduced consumption of the sample (ng vs mg for solution techniques).

These advantages make LA-ICP-MS a very attractive technique for the analysis of forensic samples, especially for trace examinations where the amount of sample always represents a challenge. The minimum amount of material that should be removed to be representative of the bulk sample may vary from matrix to matrix due to inherent degrees of micro-heterogeneity.

The aim of this work is to provide the forensic community with a critical evaluation of homogeneity of the elemental profile of some forensic samples at a micro-scale, as well as its implications to sampling size requirements, data analysis, and interpretation of results.

The micro-homogeneity of the elemental composition of glass samples (containers, architectural windows, and vehicle windshields) was studied in the types of samples commonly recovered from crime scenes. All fragments were selected with a size smaller than 2 mm² in order to simulate the typical glass fragments transferred from the crime scenarios. For each set of glasses, the mean values and standard deviation of 10 replicates (n = 10) of a single fragment were compared with the values obtained from 10 (n = 10) different fragments of glass within the area of interest (i.e., windshield pane, architectural pane and a single container) in order to evaluate whether or not the variation within a glass sample was larger than the variation due to the analytical method. In addition, several samples from a single manufacturer were analyzed. All the fragments were clear float glasses that were periodically gathered between May 1997 and September 2001.

Heterogeneity studies were conducted for the analysis of automotive and architectural paints. Two different sets of automotive paints were analyzed. The first set consisted of five blocks of red automobile paint purchased from ACT Laboratories; each block was ~ 15 cm x 10 cm. The five blocks originated from the same batch of paint and was composed of four layers. The second set was comprised of a piece of green paint (15 x 10 cm) and provided by the Royal Canadian Mounted Police (RCMP), Toronto, Canada). The sample was part of the Paint Database Query (PDQ) and consisted of six layers. For a homogeneity study within a single block, the piece was cut into 15 squared pieces of ~ 2 cm² and then 7 of those pieces were randomly selected for analysis. Four replicates per square/piece were analyzed for further statistical comparisons. An additional study was also conducted to determine the heterogeneity between the five blocks of paint. For this study, four replicates were measured on each block.

Raw soil material is significantly more heterogeneous when compared to the man-made glass and paint industrial materials described above. Therefore, homogenization of the soil standards and samples is required prior the analysis by the micro sampling tool of LA-ICP-MS.

The evaluation of homogeneity of soil and sediment matrices was conducted on pressed pellet standards using marine sediment reference material, PACS-2 (National Research Council of Canada, Ottawa, Canada) and soil reference material, SRM NIST 2710, Montana Soil (National Institute of Standards and Technology, Gaithersburg, MD, USA). The standard materials were mixed and homogenized with solid internal standards to improve accuracy and precision of the measurements. Three different ICP-MS instruments were used in standard operation modes: an HP-4500 (Agilent Technologies, Palo Alto, USA), an ELAN DRCII (PerkinElmer LAS, Shelton CT USA), and an Element 2 (Thermo Electron GmbH, Bremen, Germany). Two different laser units were utilized for this work: 1) a *New Wave UP-213* operating at 213 nm (New Wave Research, USA) and 2) a *CETAC LSX 500* (CETAC, USA) operating at 266 nm. A Scanning Electron Microscope with EDX detector (SEM/EDX) JSM-5900LV Jeol (JEOL, Japan) was used for the imaging of craters on different matrices and for determining particle size distributions within the sample.

The results demonstrate that float glass is homogenous even at the micro-range level. However, the variation of elemental composition of other glass types such containers, as well as paint and soil, is larger over the source than the instrumental variation due to inherent heterogeneity and therefore specific statistical methods are recommended to compare these more heterogeneous samples. Appropriate characterization of the heterogeneity of the control sample and incorporation of this variation into the match criteria allow LA-ICP-MS to be used as a favorable alternative technique to conduct elemental analysis of these matrices for comparison purposes.

Glass, Soil, Trace Evidence

B41 Forensic Analysis of Glass by LIBS — A Comparison to XRF and LA-ICP-MS for Elemental Profiling

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After attending this presentation, attendees will understand the role of LIBS and its impact on forensic elemental analyses.

This presentation will impact the forensic community and/or humanity by observing that LIBS is great complimentary elemental technique to aid in solving trace evidence related crimes.

Materials analysis and characterization can provide important information as evidence in legal proceedings. Although the utility of trace elemental analyses for comparisons for glass, paint fragments, bullet lead and metal fragments has been shown to offer a high degree of discrimination between different sources of these materials, the instrumentation required for the generation of good analytical data in forensic comparisons can be beyond the reach of many forensic laboratories. Scanning Electron Microscopy with an Energy Dispersive Spectrometer (SEM-EDX), X-Ray Fluorescence (XRF), Laser Ablation Inductively Coupled Plasma Atomic Emission Spectroscopy (LA-ICP-AES) and, more recently, LA-Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) have all been used in forensic laboratories for such elemental analysis determinations. Two different and recently developed Laser Induced Breakdown Spectroscopy (LIBS) instruments have been evaluated as tools for the forensic elemental analysis of glass and compared in performance to other elemental methods in order to determine the utility of comparing casework sized glass samples. The first of the two LIBS instruments utilized in this study is a Foster and

Freeman (ECCO) Laser Induced Breakdown Spectrometer (*Worcestershire, UK*) which is a self-contained device that is operated at 1064 nm, delivering a single laser pulse; the spectral range for this instrument is 200-600nm. The second LIBS instrument is a newly developed laser delivery module, custom manufactured by Photon Machines (San Diego, CA USA), coupled to an Andor Mechelle spectrometer (South Windsor, CT USA) operating in the spectral range of 200-900 nm. The new LIBS contains a New Wave Research Solo III dual cavity laser (Fremont, CA USA) capable of delivering 2 laser shots within less than a microsecond apart (two independent laser heads operating at 1064 nm) and a New Wave Research Tempest laser (Fremont, CA USA) operating at 266 nm. The laser delivery module has the capability to deliver a single pulse (@ 1064 nm or @ 266 nm), a double pulse (1064 nm followed by 266 nm and vice-versa), and a triple pulse (i.e., 1064 nm-266 nm-1064 nm). All laser combinations will be studied to enhance signal in order to improve the elemental characterization of glass samples for forensic comparisons. Such developments in the instrumental design of these LIBS systems, designed to specifically address the analytical requirements of the forensic laboratory, are also presented. The power of LIBS-based elemental analysis to discriminate between different glass samples is also compared to the discrimination power of XRF and LA-ICP-MS. The relatively low cost, ease and speed of operation, and non-destructive nature of the LIBS analysis makes the technique a potentially viable forensic elemental analysis tool.

LIBS, Glass, LA-ICP-MS

B42 Glass Sample Discrimination by Laser Induced Breakdown Spectroscopy (LIBS)

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After attending this presentation, attendees will have learned about the discrimination capability of LIBS for glass samples.

This presentation will impact the forensic community and/or humanity by introducing a new and potentially powerful elemental analysis tool, Laser Induced Breakdown Spectroscopy.

In this presentation results will be reported of a study of Laser Induced Breakdown Spectroscopy (LIBS) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) for the discrimination of evidentiary glass samples: automobile side mirror glass, automobile headlamp glasses, and brown container glasses.

Forensic glass analysis provides direct comparison of questioned and known glass samples. This research is based on analytical methods previously used. For each glass sample studied, shards from the same glass were analyzed using both LIBS and refractive index (RI) measurements, by GRIM3. All LIBS measurements were made at the National Center for Forensic Science at UCF. All refractive index measurements were made at the South Carolina State Law Enforcement Division (SLED) Columbia, SC. Pairwise comparisons were made of the data for all samples to determine discrimination factors for each technique.

The Ocean Optics LIBS2000+ system was used for data acquisition; it utilizes a Nd-YAG laser that emits at a fundamental wavelength of 1064 nm (Big Sky, model CFR200, 98 mJ/pulse, pulse width 7 ns). For the LIBS measurements, glass samples were analyzed by comparing five spectra each comprised of an average of 10 single-shot spectra (detector delay of 2 μ s) in one spot. Argon gas was

constantly flowing in the LIBS sample chamber during sampling. This data was used to select emission wavelengths that were shown to have reproducible intensities for repetitive scans in each individual set of glass samples. These emission lines were in turn used to calculate intensity ratios, a method that eliminates errors in data analysis that can be caused by laser shot-to-shot fluctuations and differences between the seven (7) different spectrometers. Ten intensity ratios were ultimately selected based on their ability to discriminate between glass samples.

Previous research has shown that it is possible to discriminate automobile samples based on their isotopic abundance using LA-ICP-MS plus the RI. The technique utilized in this study involved analyzing glass samples with a combination of LIBS elemental emission ratios and refractive index values. Each data set was evaluated by constructing a set of elemental emission ratios and determining the average and variance of those ratios over a set of replicate measurements. The emission ratios were evaluated by ANOVA to determine a set of ratios having significant F-statistic values to allow for discrimination between the glass samples comprising the set. The emission ratios were further analyzed by constructing a Pearson product moment correlation coefficient matrix and selecting those ratios displaying the lowest correlations, thereby maximizing the information content in the data set. The selected set of ratios were used to make pairwise comparison of the glass samples by means of a Tukey Honestly Significant Difference ANOVA post-hoc test to maintain prescribed data-wide significance levels at 0.10 and 0.01.

Glass samples incorporated in this study included sets of, fifteen (15) automobile headlamps samples (105 pair-wise comparisons), thirty-four (34) automobile side mirror glass (561 pair-wise comparisons), and fifteen (15) brown container glass (105 pair-wise comparisons). Discrimination capability was measured for both LIBS and LIBS+RI at 90% and 99% confidence intervals (CI). LIBS+RI gave greater than 90% discrimination (99% CI) in all data sets other than the side-mirror glass, and provided 100% discrimination of the automobile headlamp and brown container glasses (99% CI). The discrimination power of LIBS+RI was less for the side-mirror data set (79% discrimination at the 90% CI). LIBS discrimination of glass samples without the combined use of RI data was in the 53-100% range. Additional data analysis methodologies are being reviewed as alternative discrimination techniques.

LIBS, Trace Glass, Elemental Analysis

B43 Colorimetric Analysis of Glass Fragments

Paul Martin, PhD, CRAIC Technologies, 948 North Amelia Avenue, San Dimas, CA 91773; and Mike Eyring, MS, Micro Forensics, Ltd., 1141 West Glenrosa, Phoenix, AZ 85013*

After attending this presentation, attendees will learn a technique to accurately quantify color information of microscopic glass fragments and allow for simple comparison of known and questioned glass samples.

This presentation will impact the forensic community and/or humanity by introducing a new technique that will allow the criminalist to obtain objective color information on microscopic glass fragments.

Historical evidence shows that mankind started making glass approximately 5500 years ago and chiefly used it as glazes on pottery. The earliest finds of manmade glass objects were fragments of vases dating back to 1600 BC and were found in Mesopotamia. Glassblowing techniques were first developed in Syria approximately 2000 years ago and the Romans spread the techniques throughout their empire. In the 11th century, sheet glass was first developed in Germany and plate glass was originally made in France in 1688. With the advent of the industrial revolution, glass production increased and prices dropped. Glass was cheap and easily available. Because of its unique properties and low cost, many uses were found for this material.

Glass fragments are commonly found at crime scenes and can be from a number of different sources. At the scene of a car accident, these may include windshields, mirrors, and headlamps. At a burglary, the evidence may include broken windows and containers. At a homicide, the evidence may encompass eyeglasses, windows, bottles and other containers. In recent years, plastics have supplanted glass, as they tend to be more resistant to breakage. However, under energetic conditions (an automotive accident for example), plastics shatter just as easily as glass and yield similar types of microscopic evidence. While they can be readily differentiated from glass, they are more difficult to separate from one another and as such represent important evidence.

Due to the multitude of uses found for this type of material, glass is formed in many different ways and in many different colors. And because it shatters so easily, it is commonly found as microscopic shards at the crime scene and as such can be very difficult to obtain accurate colorimetric information. This is because the randomness of the shape of the glass fragments leads to refraction and diffraction of light passing through it. These optical effects can make the glass evidence appear to be one color when observed from one angle and change colors as it is rotated. When analyzed with a UV-visible range microspectrophotometer using standard techniques, refraction and diffraction cause spectral artifacts to appear. These artifacts appear in a number of different forms and include peak shifting, reshaping of peaks and dramatic changes in intensity. To date, it has been very difficult to get accurate and quantifiable color data on microscopic glass fragments because of these effects.

The purpose of this paper is to describe a technique that eliminates the spectral artifacts and allows for the microspectroscopic analysis of glass and plastic trace evidence. These techniques include sample preparation, methods of spectral data acquisition and, of course, spectral analysis, and interpretation. Sample preparation is especially critical. In this step, the refractive phenomena of the glass are eliminated by immersing the fragments in a liquid of matching refractive index. Several commonly available fluids are examined in order to find those that have the broadest spectral range, durability under high energy illumination and the closest refractive index match to a broad spectrum of glass samples. A reusable sampling cell, designed for use with upright microscopes or microspectrophotometers, is also described.

This presentation will also review the data from a number of glass samples in order to provide the examiners with representative data to aid them with their casework. This includes microscopic samples of glasses of different colors and from a multitude of sources. Micro-spectra have been acquired and are compared and contrasted in order to educate the audience on the pertinent features of the spectra.

Glass, Microspectroscopy, Colorimetry

B44 Analysis of Glass by Cathodoluminescence

Heidi D. Barron, BS, Joshua A. Gumm, BFSc, and Suzanne C. Bell, PhD, West Virginia University, 217 Clark Hall, PO Box 6045, Morgantown, WV 26506*

After attending this presentation, attendees will be familiar with the application of cathodoluminescence (CL) detection to forensic glass analysis. This presentation will cover the spectroscopy of cathodoluminescence and discuss the reproducibility of CL emission when applied to National Institute of Standards and Technology (NIST) standard glass samples.

The impact of cathodoluminescence to the analysis of glass samples will impact the forensic community and/or humanity by providing the forensic community with a new instrumental technique to analyze glass samples and provide a means to link glass from a suspect to glass found at the scene of the crime.

Glass is a common piece of evidence submitted to forensic laboratories for analysis because it can be found virtually anywhere:

automotive headlights, windows, mirrors, and eyeglasses. Automobile accidents, theft, and burglary are crimes in which glass can be the most important piece of evidence. Glass is very stable and does not degrade over time, making it easy to handle, analyze, and store. Previous work in glass analysis has been principally elemental, using laser ablation inductively coupled plasma mass spectrometry, scanning electron microscopy equipped with energy dispersive spectrometry, refractive index measurements, and X-Ray fluorescence spectrometry. This study focused on the application of the technique of cathodoluminescence to forensic glass analysis. CL detection is a technique used by geologists to investigate the internal structure of minerals. Because CL detection can provide information about the quality and composition of glass, it will enhance the information available to forensic scientists. Cathodoluminescence is a phenomenon occurring when a production of a beam of high energy electrons impacts a material, such as glass, causing it to emit visible light. CL detection is a sensitive technique that is non-destructive and does not require a high power laser. The electrons generated in a scanning electron microscope (SEM) provide sufficient conditions for CL detection. The coupling of SEM and CL detection aids in minimizing sample preparation. Sample preparation for the SEM is relatively simple and no matrix substitution is needed. SEM and CL detection are both non-destructive techniques, so the sample's integrity is maintained. For this study, a SEM equipped with a cathodoluminescence detector was used. This method of analysis, which is very popular for semiconductor analysis, has not yet been applied to forensic glass samples.

In this study, the compositions of NIST standard glass samples were analyzed. Samples of different sizes were mounted in various orientations and analyzed to assess the reproducibility of CL emission. The NIST samples analyzed were soda-lime float glass, which is the type of glass found in automotive and security windows, and multicomponent glass. Preliminary work investigating the spectroscopy of cathodoluminescence was also performed and will be discussed. Future work in this study will involve the creation of a database that is capable of comparing and matching glass fragments based on their CL emission. This will be of tremendous value to the forensic community.

Cathodoluminescence, Glass, Scanning Electron Microscopy

B45 Does the Edge Count Matter? Examining the Effect of the Edge Count on GRIM 3 Measurements

David E. Ruddell, PhD, Centre of Forensic Sciences, 25 Grosvenor Street, Toronto, Ontario M7A 2G8, Canada*

The goal of this presentation is to examine the significance of the edge count and how this quantity affects measurements taken by GRIM 3 (Glass Refractive Index Measurement). In addition, this presentation will examine some of the factors that can affect the measurement of the edge count.

This presentation will impact the forensic community and/or humanity by providing glass examiners with guidance as to when they should accept or reject measurements made by GRIM 3 based on the edge count obtained.

The ability of GRIM 3 to perform four measurements simultaneously can greatly reduce the time required to accomplish an analysis. However, it is not always possible to position the slide in such a way that four fragments with high contrast edges are available that will result in measurements with maximum edge count. The question then arises as to how the measurement of match temperature is affected when less than ideal edges are examined.

In order to isolate the effect of edge count on match temperature as much as possible, the initial analyses were performed on optical glasses. Furthermore, very small fragments of glass were used in order to

minimize the effect of any intrinsic inhomogeneity. Additional measurements were performed on samples of annealed and tempered glass to represent glass found in casework. All of these measurements were taken using a ramp rate of 4°C/min. The data was analyzed by classifying the measurements into five groups based on the edge count (0-24, 25-49, 50-74, 75-98, and 99) and comparing the mean and standard deviation (SD) of the match temperature for each group for each glass. GRIM 3 also allows for different temperature ramp rates to be used (1, 2, 4, and 5°C/min). The effect of the ramp rate on the edge count was also examined by taking measurements of the exact same edges at all four ramp rates.

The results of this study show that only for groups with edge count (0-24) and (25-49) was the mean match temperature significantly higher than for the edge count 99 group. An edge count of 99 produced the lowest standard deviation in match temperature for all glasses, with the standard deviation increasing with decreasing edge count. This increase in SD, relative to the group with an edge count of 99, was small (less than 5%) for samples in the group with edge count (75-98). The results of the ramp rate measurements demonstrate that the edge count is strongly dependent on the ramp rate. The slower the ramp rate is, the lower the resulting edge count. It was also found to be very difficult to achieve a high edge count for ramp rates of 1°C/min and 2°C/min

Based on these results, to achieve optimal accuracy and precision when using GRIM 3, obtaining an edge count of 99 for all measurements is ideal. However, the additional variation introduced by accepting edge counts in the range (75-98) is small. Therefore it is suggested that, in order to achieve optimal accuracy and precision (and in the absence of any other complicating factors), a minimum edge count of 75 should be obtained when taking measurements with GRIM 3. In addition, the examiner must be aware of the strong effect the ramp rate will have on the edge count.

Glass, GRIM, Refractive Index

B46 Drug-Facilitated Sexual Assault: The New Jersey Experience

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After attending this presentation, attendees will have gained an understanding of the prevalence of the types of drugs detected in victims of drug-facilitated sexual assault. The attendees will also gain a better understanding of sociological trends and relationships such as victim and suspect age, gender, and racial origin, and other toxicological information such as the type, prevalence, and amount of biological specimens collected.

This presentation will impact the forensic community and/or humanity by providing essential toxicological and sociological statistical information from a New Jersey population of drug-facilitated sexual assault cases.

Drug-facilitated sexual assault involves the administration of an anesthesia-type drug to render a victim physically incapacitated or helpless and thus incapable of giving or withholding consent. Victims may be unconscious during all or parts of the sexual assault and, upon regaining consciousness, may experience anterograde amnesia-the inability to recall events that occurred while under the influence of the drug.

Currently, there are no conclusive estimates as to the number of drug-facilitated sexual assaults that occur each year; however, nationwide law enforcement reporting indicates that the number of such assaults appears to be increasing. The data from 168 drug-facilitated sexual assault cases submitted to the New Jersey State Police Central

Laboratory between July 1, 2004 and January 5, 2006 were reviewed. The data was compiled to ascertain any trends in the type of drug detected, victim sociological factors such as age, gender, and racial origin and the relationships between the victims and the reported suspects. Toxicological information of interest was also compiled such as the type, prevalence, and amount of biological specimens as well as the time between the incident and specimen collection.

Females were predominately the major victim (91.7%) with an average age of 24.2 (Range = 13 – 55 years of age). The five (5) male victims in this population ranged from age 17 to 23, with an average age of 20.2. The racial origin of victims varied with Caucasian (65%) being the majority of the victim racial types reporting this crime. Likewise, Caucasian was the major racial type identified when the victim identified the racial origin of the suspect. When the racial type was reported for the suspect, 76.7% of the time the suspect's race was the same as the victim.

The State of New Jersey requests both blood and urine samples be collected from the victim of a drug-facilitated sexual assault. Blood and urine were both collected in 78.6% (132 of 168) of the cases reviewed. Urine was submitted in 92.3% (155 of 168) of the cases, and blood was submitted in 80.4% (135 of 168) of the cases. The following were the most prevalent substances identified in victim blood samples from the 168 cases reviewed: Ethanol (68.2%), Δ^9 -Tetrahydrocannabinol (14.8%), Nordiazepam (8.1%), Alprazolam (7.4%), Cocaine (7.4%), Ibuprofen (6.7%), Δ^9 -Tetrahydrocannabinol carboxylic acid (6.7%), Diazepam (5.9%), and thirty-six other drugs were detected in less than 5% of the blood samples, including one case of Gamma-Hydroxybutyrate (GHB). Rohypnol was not identified in any of the blood samples submitted. More detailed toxicological and epidemiological data will be offered in the presentation.

The purpose of this research is to gain an understanding of the contributing factors involved in drug-facilitated sexual assaults.

Drug-Facilitated Sexual Assault, Sexual Assault, Forensic Toxicology

B47 Detecting Ketamine in Beverage Residues Using GC-MS and LC-MS/MS

Sarah Stevens, and Douglas J. Beussman, PhD, St. Olaf College, Department of Chemistry, 1520 St. Olaf Avenue, Northfield, MN 55057*

After attending this presentation, attendees will gain a greater understanding of the forensic field will be obtained, which will aid in the continuing development of a relatively new teaching and research program in this area.

No published report of detecting ketamine in liquid beverage residue (or dried residue) that remains in a glass after a beverage has been consumed was found. This presentation will impact the forensic community and/or humanity by demonstrating that this analysis can be performed and that ketamine can be identified in the remaining residue left in the glass.

In today's society one is confronted with an increasingly large percent of the population that abuses illegal substances. Many of these substances are known to have hallucinogenic effects and some can even cause black outs in large doses. People have been known to take advantage of such effects and drug women in order to facilitate sexual contact, commonly known as date rape. These drugs are often slipped into an unsuspecting victim's drink. One such commonly used drug is ketamine. Several published reports already describe methods for determining the concentration of ketamine in urine, blood serum, and hair. A literature search did not reveal any published accounts discussing the detection of ketamine in drinks however. Since mass spectrometry is a sensitive analytical technique, it should be able to detect small amounts of this drug in beverages and beverage residues.

A method has been developed to determine the presence of ketamine in water, Coca-cola, and New Castle Brown Ale solutions using GC-MS and LC-MS/MS techniques. Samples, based on the lowest dose generally used for a small female in a date rape situation, were made in the three solvents and then poured into a glass. The glass was emptied to simulate consumption of the beverage and then the remaining residue was washed into a vial using nanopure water. A second sample was collected by refilling the glass, pouring out the liquid, and allowing the residue to evaporate over night. The sample was then collected by washing out the glass into a vial using nanopure water the following morning.

GC-MS analysis utilized direct-immersion solid phase microextraction technique (SPME) with a PDMS/DVB fiber and yielded positive identification of ketamine in almost all the samples. LC-MS/MS analysis used electrospray ionization mass spectrometry and direct injection liquid chromatography to detect ketamine in all the samples. LC-MS/MS was deemed the better technique because it required less preparatory work and time since the aqueous sample can be directly injected onto the chromatography column.

Attendees should expect to learn the techniques necessary to analyze ketamine samples in common beverages and beverage residues. They will learn how to use small amounts of solution to positively determine the presence of ketamine in a glass, whether the beverage contained in the glass was consumed recently, or many days earlier.

Honing and perfecting such a technique has large implications for the forensic community. A crime scene investigator could quickly obtain drink residue and test for a drug's presence before lab results from the victim were available. If the victim visited several locations, positive identification of a glass containing the drug in conjunction with a positive test for the drug in the victim's blood or urine could help determine where the spiking of the drink occurred. Forensic science would benefit from having such a technique available to help solve cases involving this date rape drug.

Ketamine, Beverage, Mass Spectrometry

B48 Determination of Methamphetamine on the Surface With Drugwipe® Analytical Device

Elzbieta J. Kubicz, PhD, Wyoming State Crime Laboratory, 316 West 22nd Street, Cheyenne, WY 82002*

After attending this presentation, attendees will understand the use of Drugwipe® to detect methamphetamine and other drugs in sweat, saliva, and on surfaces.

This presentation will impact the forensic community and/or humanity by demonstrating how Drugwipe® is a simple, non-expensive presumptive test.

The connection between substance abuse and criminal activity is clear. Since the 1990s, methamphetamine has been considered the primary drug threat in Wyoming and has been a priority for state and local law enforcement agencies. Methamphetamine is a powerful stimulant which affects the central nervous system and causes behaviors such as anxiety, insomnia, paranoia, hallucinations, mood swings, and delusions. Both meth producers and abusers have been involved in violent crimes in Wyoming to obtain money to support their meth habits. A startling number of these crimes include domestic violence ranging from child neglect to homicide. Of the six neglect and abuse related deaths of children investigated by the Wyoming Child Fatality Review Board in 2003, 5 were associated with meth use by parents or caregivers.

Methamphetamine is truly a substance that has had direct effect on criminal activity in Wyoming (State of Wyoming, Department of Health, Substance Abuse, January 2005).

This statistics alone indicates the need for a device for speedy on-site detection and identification of the presence of Methamphetamine.

Drugwipe® from Securetec meets these requirements. The main advantages of Drugwipe® are its small size, fast response time, and low false positives.

The presentation will focus only on the detection of traces of the drug on surfaces (test can be used also on the skin-sweat or in saliva).

Validation studies of this product have been performed by several laboratories; among them: Securetec, German Traffic Police, ROSITA and gave very promising results. Major goals are to test selectivity of methamphetamine answer on multi-testing capability of Drugwipe® assays in one device and recover the sample after testing for the definitive analysis.

Methamphetamine, Drugwipe®, Detection

B49 Variability in the Organic Impurity Profile in Amphetamine Sulfate Made by the Same Chemist

Niamh Nic Daeid, PhD, Center for Forensic Science, Dept of Pure and Applied Chemistry, Royal College, 204 George Street, Glasgow, Scotland G1 1XW, United Kingdom; William J. Kerr, PhD, Department of Pure and Applied Chemistry, WestCHEM, University of Strathclyde, Royal College, 204 George Street, Glasgow, Scotland G11XW, United Kingdom; and Hilary S. Buchanan, MSc, and Michael Middleditch, PhD, Department of Pure and Applied Chemistry, Royal College, 204 George Street, Glasgow, Scotland G1 1XW, United Kingdom*

After attending this presentation, attendees will understand drug profiling, amphetamines, and clandestine synthesis.

This presentation will impact the forensic community and/or humanity by demonstrating some valuable insights into the variations that can occur in organic impurity profiles produced for samples synthesized by the same chemist.

One of the most important underpinning assumptions in organic impurity profiling of synthetic drugs such as amphetamine, methylamphetamine and MDMA is that drugs produced by the same chemist or same clandestine laboratory can be linked together through analysis of the reaction products. This research explores this assumption through simulating the production of one of these controlled substances, amphetamine sulfate.

A common route of synthesis for amphetamine sulfate is via the Leuckart reaction. The reaction is easily achievable even by the relatively inexperienced chemist. The synthetic reaction produces a range of reaction impurities, some of which are exclusive to the production method. In many clandestine laboratories engaged in the production of amphetamine sulfate an experienced chemist may have an initial advisory rather than hands on role. That is to say they may be involved in the training of more inexperienced individuals who will engage in the day to day synthetic chemistry involved in the manufacture of the drug in question.

In this work a chemist inexperienced in the manufacture of amphetamine sulfate was schooled in its production. A number of batches of amphetamine sulfate were synthesized within the university laboratories, by the same chemist using the two step Leuckart synthesis. The starting products (benzyl methyl ketone, formamide, and formic acid) were all purchased in the UK. The reaction follows a simple two stage process: a formylation stage, in which an *N*-alkylformamide is the main reaction product, followed by acid hydrolysis, and finally extraction of the sulfate salt from ether using sulfuric acid.

The reaction impurities for each sample were extracted and analyzed using GCMS to recover the organic impurity profile. Data analysis, including HCA and PCA, was conducted to determine whether or not the samples could be linked together. The results of these analyses and their wider implications for organic impurity profiling of amphetamine sulfate samples are presented in this paper.

Drug Profiling, Clandestine Synthesis, Amphetamine

B50 Birch Reduction of Pyrilamine: A New Clandestine Methamphetamine By-Product?

Sara K. Lee, BS, Marshall University, Forensic Science Program,
1401 Forensic Science Drive, Huntington, WV 25701-3628*

After attending this presentation, attendees will have learned about compounds that would help identify the method used and possible precursor source of clandestine methamphetamine labs. Several analytical techniques are offered to help drug chemists identify the compounds.

This presentation will impact the forensic community and/or humanity by demonstrating how the Birch reduction method and the indicators that may elucidate the route used in a clandestine lab setting. The information could help law enforcement personnel identify less-restricted pseudoephedrine products that may be targeted for illicit meth production.

The Birch reduction method is a procedure used by some clandestine lab cooks to make illicit methamphetamine. The process requires pseudoephedrine as a precursor, but due to recent legislation placed on the sale of pseudoephedrine products, cooks may look toward veterinary medicine as an alternate source. Pyrilamine maleate is a compound found in conjunction with pseudoephedrine, and when subjected to the Birch reaction, may produce unique by-products. An analytical profile of pyrilamine was generated by gas chromatography (GC) screen, gas chromatography-mass spectrometry (GC-MS), Fourier transform infrared (FTIR) and nuclear magnetic resonance (NMR) tests. The Birch reduction of pyrilamine was conducted using two methods, and the unknown products were distinguished via GC screen, GC-MS, and NMR analyses. Reaction 1 resulted in the loss of the pyridine ring of pyrilamine; the product from reaction two has yet to be determined.

Birch, Reduction, Pyrilamine

B51 Biotransformation of Benzaldehyde to l-Ephedrine

Tamara L. Dallabetta-Keller, BS, Angela R. Wacker, BA, and Carissa Stark, MS, Drug Enforcement Administration South Central
Laboratory, 10150 East Technology Boulevard, Dallas, TX 75220*

The goal of this presentation is to update the attendee's knowledge in clandestine laboratories and the most recent trends of manufacturing in the U.S.

This presentation will impact the forensic community and/or humanity by educating the drug analysis portion of the forensic community in recent trends for manufacturing methamphetamine.

Due to recent legislation regulating pseudoephedrine sales, the supply of precursor chemicals for the manufacturing of methamphetamine has been limited. Traditionally, extraction from the plant species *Ephedra* and a synthetic chemical process of production was utilized. Many methods have been employed for the production of l-ephedrine. In recent years, an underground network of information has included a biotransformation process involving benzaldehyde by yeast and molasses. This process utilizes traditional fermentation principles with the use of yeast and a type of substrate, in this case, molasses. The Drug Enforcement Administration's South Central Laboratory received an assistance call involving the aforementioned process. Up to this point, the biotransformation method had not been encountered in any literature relating to methamphetamine manufacturing. It was determined that the biotransformation of benzaldehyde to l-phenylacetylcarbinol (l-PAC), which can then be hydrogenated into l-ephedrine with methylamine and platinum shavings, is a viable process.

Methamphetamine, Ephedrine, Biotransformation

B52 Controlled Substance Prescription Drug Evidence Analyzed by State and Local Crime Laboratories in the United States Over a Five-Year Period

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Navy Drive, Arlington, VA 22202; and Michael R. Baylor, PhD, Kevin J.
Strom, PhD, Belinda J. Weimer, MS, Jeffrey M. Ancheta, BS, and Joseph
V. Rachal, MS, RTI International, 3040 Cornwallis Road, PO Box 12194,
Research Triangle Park, NC 27709-2194*

After attending this presentation, attendees will have an enhanced understanding of the distribution of prescription drug seizures and diversion of selected pharmaceutical drugs over a five-year period (2001 through 2005) and geographical regions. The presentation will be based on laboratory analysis and drug identification data of narcotic analgesics and benzodiazepines from the National Forensic Laboratory Information System (NFLIS).

This presentation will impact the forensic community and/or humanity by providing a crucial aspect of the extent in which many pharmaceutical drugs are diverted by comparing prescription data to forensic laboratory data. Only with a more comprehensive data collection and analyses by the forensic community can controlled pharmaceutical drug trafficking and availability in the U.S. be more effectively measured.

The non-medical use of controlled substance prescription drugs is a serious and growing problem in the United States that is being aggressively pursued through various initiatives in U.S. national drug control policies. Controlled substance prescription drugs, as a group, represent the second-most commonly abused substance behind marijuana and ahead of drugs such as cocaine, heroin, and methamphetamine. From 2001 to 2005, narcotic analgesics and benzodiazepines together represented nearly 5% of all drug items analyzed by state and local crime laboratories in the United States. An estimated 258,048 narcotic analgesic items and 181,384 benzodiazepine drug items were analyzed during this period. The estimated number of prescriptions dispensed per drug item reported in NFLIS for 2001 through 2005 indicates that methadone, diazepam, alprazolam, morphine, and oxycodone had low prescription-to-seizure ratios compared to other drugs, indicating a higher level of diversion. Alprazolam (101,135), hydrocodone (89,554), and oxycodone (85,328 items) were the most commonly reported prescription drugs from 2001 to 2005, representing nearly 63% of narcotic analgesics and benzodiazepines. In 2005, alprazolam was the fifth, hydrocodone was the sixth, and oxycodone was the eighth most common drug reported in NFLIS. Highlighted findings will include the regional findings where in the West, the most prevalent narcotic analgesic, and benzodiazepine drug item identified was hydrocodone (24%), while in the Midwest and South alprazolam was identified as 22% and 27% respectively. In the Northeast, 30% of narcotic analgesics and benzodiazepines were identified as oxycodone. Additional data will show population adjusted regional trends and also depict spatial distribution of controlled substance prescription drug seizures and availability by using Geographic Information System (GIS) display functionality.

Laboratories participating in NFLIS analyze and report on drug evidence secured in law enforcement operations, offering a unique resource for monitoring drug abuse and trafficking, including the diversion of legally manufactured drugs into illegal markets. NFLIS is an important analytical resource for drug policy and can provide timely information on the illicit trafficking of prescribed drugs across the United States.

**Pharmaceutical Diversion, Prescription Drug Analysis,
Drug Seizures**

B53 Analysis by HPLC-MS of Counterfeit and Imitations of Viagra®

Roberto Gagliano Candela, PhD, University of Bari, Dipartimento Medicina Interna Medicina Pubblica, Policlinico, Piazza G. Cesare n.11, Bari, Italy 70124; Fausto Gigli, PhD, and Di Candia Nicola, PhD, Sez. Autonoma di Tossicologia Forense – Ist. Medicina Legale, Università di Milano, Via Mangiagalli 37, Milano, Italy 50100; and Anna Pia Colucci, PhD, and Giuseppe Strisciullo, University of Bari, Dipartimento Medicina Interna Medicina Pubblica, Policlinico, Piazza G. Cesare n.11, Bari, Italy 70124*

After attending this presentation, attendees will understand the counterfeiting and imitations of the drug Viagra and other generic containing less active ingredient can pose significant risks.

This presentation will impact the forensic community and/or humanity by studying the qualitative and quantitative variability of the active principle in tablets sold in illicit market, checking the homogeneity of a batch, and distinguishing counterfeits and imitations from authentic Viagra®.

Goal: Pharmaceutical counterfeiting is becoming a serious problem both in developed and developing countries. The aims of this work are: a) study the qualitative and quantitative variability of the active principle in tablets sold in illicit market; b) check the homogeneity of a batch; c) distinguish counterfeits and imitations from authentic Viagra®.

Methods: Instruments: HPLC-MS (Agilent Technologies LC 1100-MSD Trap XCD Plus); column Zorbax XDB-Phenyl 2.1x50 mm, 3.5 µm.

Selected ion monitoring: m/z 377.2 (sildenafil), 368.2 (ethaverine)

Samples: Eighty-six tablets derived from judicial attachments of five different counterfeit drugs: Pesigra 50, Novagra 100, Kamagra 100, Vegatone 50, Viagra 100.

Results: The sildenafil citrate reported on the blister is quite different from measured quantity.

Analyzed tablets of Pesigra 50 contain from 9.27 mg to 14.20 mg of sildenafil citrate instead of reported 50 mg; Novagra 100 tablets contain from 16.65 mg to 26.16 mg instead of reported 100 mg; Kamagra 100 tablets contain from 16.00 mg to 24.59 mg instead of reported 100 mg; Vegatone 50 tablets contain from 5.43 mg to 10.92 mg instead of reported 50 mg; Viagra 100 tablets contains from 0.86 mg to 12.75 mg instead of reported 100 mg.

The method was validated for intraday and day to day precision, accuracy, LOD and LOQ.

Conclusions: Counterfeiting and imitations of the drug Viagra® and its generic, a treatment for erectile dysfunction, containing less active ingredients can pose significant risks.

Viagra®, Counterfeit Drugs, HPLC-MS

B54 Optimization of Solid-Phase Microextraction/GC-MS for the Extraction of Organic Impurities in Seized MDMA

Heather M. Dotzauer, BS, and Ruth J.H. Waddell, PhD, Michigan State University, Forensic Science Program, 560 Baker Hall, East Lansing, MI 48824*

After attending this presentation, attendees will understand the application of experimental design to the optimization of headspace solid-phase microextraction (HS-SPME), the benefits of HS-SPME for the extraction of organic impurities from seized MDMA tablets, and the need for profiling illicit MDMA.

This presentation will impact the forensic community and/or humanity by the parameters for impurity extraction using HS-SPME, which has numerous advantages over conventional extraction

procedures. Once optimized, HS-SPME can be used to extract impurities from seized MDMA tablets and the extracts subsequently analyzed by GC-MS. Chromatographic profiles of tablets can be compared using computer-aided procedures, such as artificial neural networks.

Commonly referred to as the club drug “ecstasy,” MDMA (3,4-methylenedioxyamphetamine) is a schedule I drug with stimulant and psychoactive properties. A 2005 report by the National Forensic Laboratory Information System (NFLIS) showed that MDMA is one of the 25 drugs most frequently identified by regional, state, and national laboratories. According to the NFLIS, MDMA makes up 0.71% of the cases analyzed each year. Between January and June of 2005, MDMA was identified in 6,238 cases nationwide.¹

Chemical profiling of MDMA aids law enforcement agencies by linking tablets to common production methods based on the impurities present. Tablets with the same impurities present in similar levels may have a common origin. Law enforcement can then use the information generated from the profiles to monitor the activities of clandestine laboratories, identify dealer-user networks, and expose drug-trafficking organizations.

Traditionally, organic impurities are extracted from tablets by liquid-liquid extraction (LLE) or solid phase extraction (SPE) methods, with subsequent analysis and identification by GC-MS. HS-SPME is a promising alternative to these conventional extraction procedures. In this procedure, a thin, polymeric fiber is used to absorb and adsorb impurities from the headspace above a sample. Impurities are then desorbed from the fiber and analyzed by GC-MS. HS-SPME is advantageous because it decreases sample preparation time and solvent use.

Methods for the extraction of organic impurities from illicit MDMA tablets using HS-SPME have been developed and optimized using an experimental design procedure. The benefits of the experimental design in assessing the relative effect of each parameter on extraction efficiency and predicting interdependence between factors are presented. The optimized HS-SPME method was also compared to LLE and SPE methods in terms of extraction efficiency; results will be presented.

¹ *National Forensic Laboratory Information System Midyear Report. DEA Office of Diversion Control. 2005.*

MDMA, Impurity Profiling, Solid-Phase Microextraction

B55 Degradation of Heroin in Solid and Biological Samples

Rebecca D. Hanes, BS, Dina Shakleya, PhD, and Suzanne C. Bell, PhD, West Virginia University, 217 Clark Hall, Morgantown, WV 26506*

After attending this presentation, attendees will learn about the rate at which heroin breaks down into 6-acetyl-morphine and morphine, as a function of the containers in which the samples are stored, the temperature and the humidity. An indispensable aspect of such information will help toxicologists and drug chemists more accurately determine the age of the heroin sample.

This presentation will impact the forensic community and/or humanity by demonstrating a more accurate concentration of heroin originally in the sample can be found by determining the rate of degradation of heroin and studying the ratio of heroin to these products. This will also help toxicologists calculate a more accurate value for the amount of heroin present in biological fluids.

Heroin is a controlled substance that degrades over time. The breakdown of heroin has been explored previously with the intention of monitoring the change in heroin concentration. Previous experiments have monitored the change by varying the temperature. As heroin degrades, the increasing concentration of 6-acetyl-morphine and morphine become more apparent and more dominant in spectral

analysis. Specific analytical techniques have previously been geared to focus only on the degradation of heroin in its pure, solid form. This information, while informative, provides little “real case” insight into the true concentration of heroin in samples obtained in either drug seizures or biological fluids. By studying the degradation products created in this process at varied temperatures, a relationship can be made between the decrease in heroin and the relative amount of 6-acetylmorphine and morphine. High performance liquid chromatography (HPLC) with ultra-violet and fluorescent light detection provides complementary information about the pure drug and its degradation products.

Weather conditions, humidity, and packaging all influence the aging process of heroin. The samples analyzed in this study consisted of pure heroin, pure lactose, and a 20/80 weight percent heroin/lactose mixture. The three samples were placed in two types of containers: Teflon balloons and plastic bags. Each package was then aged in four different environments of varying temperature and humidity. A control sample of pure heroin was placed in a glass vial and kept at -80°C to prevent any change in the standard. The 100 μg of each sample was analyzed by HPLC. The analysis was carried out in an ammonium acetate buffer at pH 6.00. Fluorescence and ultra-violet light detectors were used in tandem to help establish the relationship between heroin and its degradation products. Samples were taken every 6 hours for the first 3 days to establish an initial base line, and additional samples were then taken every 12 hours.

As previously demonstrated in other works, the increase in the temperature of the environment increases the rate of heroin degradation. The humidity and packaging used also contributed to the breakdown process.

The goal of this project was to develop a method to quantify the aging process of heroin in seized samples and in biological fluids. By determining the ratio of heroin to one or both of its degradation products, a more accurate heroin concentration in both drug samples and biological samples can be calculated.

Heroin, Degradation, Degradation Products

B56 Detection of Volatile Drugs of Abuse and Related Compounds in Breath Using Ion Mobility Spectrometry

Amy R. Aylor, BS, and Joshua A. Gunn, BfSc, West Virginia University, C. Eugene Bennett Department of Chemistry, 217 Clark Hall, Morgantown, WV 26506*

The goal of this presentation is to discuss the use of ion mobility spectrometry (IMS) to screen breath for the presence of volatile drugs of abuse and related compounds. Attendees will learn of the potential for IMS to be used for such an application and the supporting evidence and concepts for such a claim.

This presentation will impact the forensic community and/or humanity by proving the concept that volatile pyrolytic products of drugs of abuse may potentially be screened for using a method analogous to that used for blood-alcohol.

The analysis of breath as a screening tool for the estimation of blood alcohol concentration is a scientifically and legally validated technology. Because breath sampling is non-invasive, it represents an ideal forensic sampling matrix. Clinically, significant attention has been paid to the detection of volatile metabolites and biomarkers of lung cancer detected in exhaled air. Other studies have focused on exhaled breath as a means of assessing exposure to volatile organic compounds. However, aside from breath alcohol, few applications have been reported in the forensic arena.

Smoked drugs of abuse, such as methamphetamine, cocaine, and phenacyclidine (PCP) enter alveolar gas during and immediately

following inhalation. A portion of these is immediately exhaled, while another portion will adsorb into lung tissues. The remainder equilibrates rapidly with organic compounds in the capillary blood to enter the bloodstream. Following pulmonary output, metabolites again rapidly equilibrate with alveolar gas volatile compounds and comprise alveolar breath during the expiratory phase.

Breath is a plentiful sample matrix available for screening tests in forensic toxicology. Sampling is non-invasive and the general methodology has been vetted by over half a century of breath alcohol testing. The goal of the present study was to provide proof-of-concept for the use of ion mobility spectrometry (IMS) to screen breath for a larger pool of volatiles associated with drugs of abuse. Drugs of abuse and related compounds, such as pyrolytic products and the following known biomarkers of smoked methamphetamine, cocaine, and phenacyclidine (PCP), respectively: 1-phenylpropene, anhydroecgonine methyl ester (AEME), and 1-phenyl-1-cyclohexene. Ethanol, methanol, isopropanol, acetaldehyde, acetone, caffeine, and nicotine were examined as possible interferents. Henry's law constants (K_H) and pharmacokinetic parameters were used to estimate the range of expected breath concentrations. IMS response in positive ion mode was determined across this range from aqueous solutions and air. Limits of detection for these compounds were found to be in the low parts-per-million range in breath for all compounds, corresponding to typical blood concentration levels reported in the literature. No significant interferences were noted.

Pyrolysis, IMS, Drugs of Abuse

B57 Using Isotope Ratio Methods to Investigate Linkages in Amphetamine Sulfate Samples

Hilary S. Buchanan, MSc, and Niamh Nic Daeid, PhD, Center for Forensic Science, Department of Pure and Applied Chemistry, Royal College, 204 George Street, Glasgow, Scotland G1 1XW, United Kingdom; and Wolfram Meier-Augenstein, PhD, Environmental Forensics & Human Health Laboratory, EERC, Queen's University Belfast, Belfast, BT9 5AG, United Kingdom*

After attending this presentation, attendees will understand isotope ratio analysis of drugs as a profiling tool.

This presentation will impact the forensic community and/or humanity by providing an exploration into the potential for IRMA to link within and between batch synthesized amphetamine samples of known provenance and illustrating the power of the technique to provide intelligence for forensic chemists and law enforcement.

On the basis of GC/MS data alone, it may not be possible to conclusively link together batches of amphetamine drugs (of methyl amphetamine, MDMA etc) since their manufacture produces a complex pattern of impurities which are not always repeatable on analysis. Analytical methods currently applied in forensic science laboratories establish a degree of identity between one substance and another by means of identifying its constituent elements, functional groups, and by elucidating its chemical structure. Should the chromatographic and spectroscopic data of two compounds correspond, it may be concluded that they are chemically indistinguishable.

However, an argument which is put forth with increasing frequency is that even if two substances in question are chemically indistinguishable it cannot be concluded with certainty that they are the same, i.e., that they share the same origin and are, hence are derived from the same source. Isotope abundance analysis by IRMS can provide the answer to this question and can identify whether substances, which share a common trait or characteristic, are from a common origin. With the help of stable isotope profiling, forensic scientists will be able to link a person to an event, a crime scene, or a criminal organization (such as a drug cartel) based on a unique characteristic of physical evidence. By combining Carbon, Hydrogen and Nitrogen isotopic ratio values from

stable isotope analysis of seized “ecstasy” tablets, preliminary work has given an indication of how bulk stable isotope analysis (BSIA) of ground tablet material could be used as a fast screening tool to determine if tablets from separate seizures are linked to a particular batch thus providing an avenue for generating data that can be used for intelligence led policing and potentially as evidence in a court of law. Figure 1 illustrates similar data resulting from IRMS analysis of seized amphetamine samples indicating sample linkages.

A number of batches of amphetamine sulphate were synthesised within university laboratories, in this case by the same chemist using the two step Leuckart Synthesis. The starting products (Benzyl Methone Ketone, Formamide and Formic acid) were all purchased in the UK and the reaction takes two steps; a formylation stage followed by acid hydrolysis. Each batch was analyzed at various stages during the refinement process using bulk isotope ratio analysis for carbon, nitrogen, and hydrogen and the final product was similarly analyzed. The amphetamine sulphate produced was then cut with common diluents and re analyzed using both Bulk and compound specific stable Isotope analysis to determine the effect. Each amphetamine sulphate sample was also extracted to capture the reaction impurities and partially reacted products formed during the synthesis. These were analyzed using GCMS to determine the impurity profile and the results compared with the IRMS analysis. These results are presented in this poster.

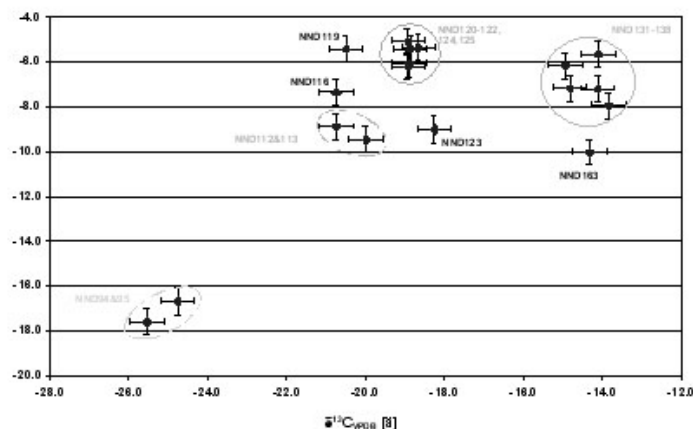


Figure 1

Isotope Ratio, Clandestine Drugs, Intelligence

B58 Validation and Application of an STR Multiplex for Discrimination of *Cannabis Sativa* Individuals

Maria Angelica Mendoza, MS*, 710 SW 114th Avenue, Apartment C1, Miami, FL 33174; and José R. Almirall, PhD, Florida International University, Department of Chemistry and Biochemistry, 11200 SW 8th Street, CP194, Miami, FL 33199

After attending this presentation, attendees will understand the efforts to multiplex ten STR markers previously described and known to discriminate between individual cannabis plants into a single reaction.

This presentation will impact the forensic community and/or humanity by demonstrating the practicality of multiplexing primers sets to differentiate individual plants within the *cannabis sativa* species.

Cannabis sativa L. plants can be easily identified through morphological examination and chemical analysis; however there is an interest within the law enforcement investigation community for DNA analysis of these plants with the potential to differentiate between individual plants. This method can be used as a means of associating criminal cases and tracking cannabis distribution networks. *Cannabis sativa* L. is the most frequently used of all illicit drugs in the United States. Cannabis has been used throughout history for its stems in the production of fiber, for its seed for oil and food and for its flowers and leaves as a psychoactive drug. Short tandem repeat, STR, markers are advantageous over other markers due to their reproducibility, high discrimination power and their multiplexing capacity.

In this research project, a total of ten previously described STR markers were multiplexed into a single reaction. Five primers were selected from a set of primers previously described by FIU group¹ four from a set previously described by Gilmore’s group² and the highly polymorphic primer described by Hsieh et al³. Where appropriate, trinucleotide repeats were chosen to reduce the incidence of artifacts that may affect interpretation. The forward primers of the primer sets were fluorescently tagged with either 6-FAM dye, HEX or VIC dye. Hemp DNA extracts were provided by the Alberta Research Council in Alberta, Canada. Marijuana DNA extracts were provided by the Nederlands Forensisch Instituut in Den Haag, Holland. Marijuana leaves were provided by the law enforcement agencies in Florida. The DNA was extracted from the leaf samples using a plant DNA extraction kit. The multiplex reaction was used to analyze 25 different cannabis plants. The samples were amplified in a single optimized reaction to determine base pair size for each allele. The primers were then combined into a single multiplexed reaction and amplified on a thermal cycler followed by analysis on a capillary electrophoresis, CE. The results were then analyzed using appropriate software. Studies using these STR markers were able to distinguish clones from non-clones. Efforts to determine the level of polymorphism and to measure the genetic relationships between different cannabis plants are also presented. There were a total of 25 individual *Cannabis sativa* plants analyzed, 14 with a low Δ^9 tetrahydrocannabinol, THC, content and 11 with a high THC content, in addition to a set of different plants retrieved in the State of Florida at different geographic locations.

This project determined the practicality of multiplexing primers sets to differentiate individual plants within the *Cannabis sativa* species. Using previously described primer sets, a working multiplex which could differentiate 25 individual cannabis samples was obtained. During testing it was determined that there was no significant difference in base pair size between alleles typed using the single locus amplification and the multiplexed amplification. Each cannabis sample gave a unique profile showing clear differences between the generated genotypes.

References:

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- 2 S. Gilmore and R. Peakall, Isolation of microsatellite markers in *Cannabis sativa* L. (marijuana). *Molecular Ecology Notes* 2003, 3: 105-107.
- 3 H.M. Hsieh, R.J. Hou, L.C. Tsai, C.S. Wei, S.W. Liu, L.H. Huang, Y.C. Kuo, A. Linacre, J.C. Lee, A highly polymorphic STR locus in *Cannabis sativa*, *Forensic Sci. Int.* 2003, 131: 53-58.

Cannabis DNA, STRs, Multiplex

B59 Performance of the Reflected Ultraviolet Imaging System (RUVIS) in Visualizing Latent Fingerprints on Various Non-Porous and Semi-Porous Surfaces

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After attending this presentation, attendees will understand the correlation between surface chemistry and the ability of the Reflected Ultraviolet Imaging System (RUVIS) to make clear the minutiae of fingerprints on various surface types and under various conditions.

This presentation will impact the forensic community and/or humanity by improving efficiency in the use of the RUVIS in forensic laboratories; it arms fingerprint examiners with the knowledge of which surface types are amenable to RUVIS use. This results in an improved ability to scan large surfaces in order to locate fingerprints, as well as the ability to clearly visualize individual fingerprints on difficult surfaces.

The RUVIS is a hand-held scope through which latent fingerprints appear visible under UV lighting. This is an extremely effective tool for scanning large areas to locate prints, as well as a quick and valuable method for visualizing individual fingerprints, especially on complicated backgrounds.

This study analyzes eight surfaces, each presenting a unique challenge to fingerprint examiners while at the same time being commonly encountered in fingerprint cases. The texturing of Styrofoam, wood veneer, and textured plastics provides difficulty in visualizing fingerprint minutiae. CDs have a highly reflective surface, making the print difficult to separate from its reflection. Magazine pages have highly variable backgrounds which may obscure fingerprint detail. Plastic bags, smooth metal, and glass serve as control substrates, since they are excellent substrates for high quality fingerprints.

The surface chemistry of the eight surfaces is characterized based on surface energy, surface roughness, surface wettability (a corollary to porosity), and elemental composition. These characteristics affect both how the surface accepts a fingerprint, and how the RUVIS interacts with the surface.

To make the study as close an approximation as possible to the conditions a crime scene fingerprint would experience, the test prints are subjected to various environmental conditions (such as simulated sunlight, water submersion, and darkness). Each fingerprint is visualized using RUVIS, then using traditional methods (cyanoacrylate fuming and physical developer). Finally, each print is observed with RUVIS yet again. This serves as a control for inherently poor quality prints, as well as allowing a determination of whether the RUVIS provides significant improvement over traditional methods.

Evaluation of the fingerprints is performed by grouping prints into quality categories using a point system based on the visibility of the core, the delta, and the number of visible minutiae. Statistical analysis then reveals whether there are significant correlations between print quality and the surface characteristics of the surface on which the print was placed and observed.

The value of this study lies in its potential to make RUVIS more usable in the forensic context, and therefore to make fingerprint processing faster and more efficient. If a clear correlation is established between one or two surface characteristics and RUVIS performance, it is likely that a simple test of surface characteristics would allow the fingerprint examiner to determine whether or not to use RUVIS. Examiners armed with the knowledge of surface types not amenable to RUVIS would not miss potentially critical fingerprints by scanning those surfaces at a crime scene in lieu of traditional processing methods.

The study also aims to determine whether RUVIS is more effective before or after the traditional processing methods used (cyanoacrylate fuming and physical developer), and therefore allow fingerprint examiners to get the best results possible from its use in the laboratory.

Though these effects may seem minor, they could add up to improve the performance of latent print units and the clearance of cases. With as high a caseload as is pressed on almost every forensic laboratory in the country, increased efficiency is not a minor detail.

Fingerprints, Surface Chemistry, RUVIS

B60 Analysis of Nuclear DNA From Exploded Bomb Fragments and Spent Cartridge Casings

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After attending this presentation, attendees will understand the strengths and limitations of STR analysis on human DNA recovered from exploded bomb fragments and spent cartridge casings.

This presentation will impact the forensic community and/or humanity by demonstrating the probative value of DNA evidence from explosive devices and firearms and the limitations of standard analytical methods with the testing of low copy number DNA samples.

The purpose of this research was to evaluate the persistence and condition of human DNA recovered from the fragments of exploded, simulated pipe bombs and from the cartridge casings and inner workings of discharged firearms. In this study, the DNA samples were quantified by Real-Time PCR with the ABI Quantifiler™ Kit and the ABI Prism® 7000 Sequence Detection System. The samples were STR typed by use of the AmpFISTR® Identifiler® PCR Amplification Kit and the ABI Prism® 310 Genetic Analyzer. The genotyping data was analyzed with the GeneMapper® ID Software v3.2, and the peak amplitude threshold was set at 25 RFU.

In the first experiment, liquid human blood was liberally applied to the edges of four longitudinal sections of pipe. Four different pipes were used: galvanized steel, copper, iron, and PVC. A small amount of C6 was placed in each half-section of pipe. The explosive devices were covered with a bomb blanket and detonated within a concrete cylinder with a dirt floor. The fragments were collected and examined for blood. The blood on the fragments was visible macroscopically as blackened stains. Complete STR profiles were obtained from the swab samples of the bloodstains on the four pipe sections.

In the second experiment, a known quantity of DNA (in the form of blood) was deposited on the surface of the casing of three .25 caliber, three .380 caliber, and three 9mm cartridges, which were then discharged from the appropriate firearm. A swabbing was taken of each spent casing and analyzed. The average amount of DNA recovered from the casings was less than half of the starting amount; however, complete STR profiles were obtained from all of the casings.

In the third experiment, five female and five male subjects each loaded three 9 mm cartridges into a 9 mm Luger magazine. The subjects were instructed not to wash their hands one hour prior to handling the ammunition. The cartridges were discharged, and the casings were sampled by swabbing. The amount of DNA recovered from the casing samples ranged from zero to 0.93 ng. Limited typing information was derived from these samples. Many samples showed discordant typing results with a peak amplitude threshold of 25 RFU.

This study demonstrates that, under the test conditions, human DNA can persist on exploded bomb fragments and spent cartridge casings in a quantity and quality suitable for typing. However, the success of the analysis is limited by the amounts of DNA deposited on these items through handling.

Exploded Bomb Fragments, Spent Cartridge Casings, Discharged Firearms

B61 Mitochondrial DNA Amplification Success Rate as a Function of Hair Morphology

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After attending this presentation, attendees will have a better the understanding of the factors that influence amplification success rate in hair tissue.

This is a controlled study that considered amplification success as a function of several hair morphology characteristics. This presentation will impact the forensic community and/or humanity by demonstrating how this data may be compared to results obtained from casework samples in order to evaluate the potential factors that may contribute to a reduced amplification success.

This study examines the amplification success rate of mitochondrial DNA from human head hair and bloodstains with respect to their potential for forensic application. Mitochondrial DNA was isolated using a Chelex-based extraction method and amplified using the LINEAR ARRAY™ duplex PCR system. The particular focus of this study was to characterize the morphological features of human head hair in order to further the understanding of the factors that influence amplification success rate in hair tissue using the LINEAR ARRAY™ duplex PCR system.

131 bloodstains and 2554 head hairs from 132 individuals representing four population groups were amplified. The hair samples were characterized as follows: 1251 were identified microscopically as telogen hairs and 1303 were classified as hairs without roots (removed prior to extraction). Amplification success was assessed as a function of several independent variables: morphological characteristics; telogen root v. no root; donor age; scalp origin; use of cosmetic hair treatments; and race of the donor.

The results show that a positive correlation exists between amplification success and the presence of a telogen root. Combining the amplification success with either the original or optimized protocol, telogen hairs result in an overall success rate of 77.5% compared with 65% for hairs with no roots. Controlling for telogen hairs, the findings indicate that the overall success rate is independent of cosmetic hair treatments, medulla structure, shaft diameter, and scalp origin. Conversely, the age of the donor, the race of the donor, and hair pigmentation all contribute to a variation in amplification success rate.

Amplification Success, Mitochondrial DNA, Hair Morphology

B62 Identification of Exhumed Human Remains Using a Bone DNA Extraction Kit and a Low Copy Number Approach for STR Markers

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After attending this presentation, attendees will be briefed on a method for DNA extraction from exhumed remains recommended for ancient bone samples and interpretation based on low copy number DNA strategy.

This presentation will impact the forensic community and/or humanity by demonstrating how this method or approach may increase the ability to obtain STR marker data from challenging human remains

This presentation illustrates the use of an ancient bone extraction protocol for recovery of DNA from exhumed bones that were buried for more than ten years. The chemicals used in embalming and the natural decomposition processes can drastically reduce the ability to recover nuclear DNA that is of sufficient quality to generate even a partial short tandem repeat (STR) profile. Typically, teeth and long bones such as the femur are most successful in generating a DNA profile with STR markers. In this case, teeth were not available as samples and the femur failed to generate a DNA profile.

This case example began as a civil lawsuit for failure of a funeral home to notify the family of a burial. More than 10 years later, the family was still not confident that the human remains in the coffin were that of their deceased family member. The body was exhumed, examined for identifiable clothing or physical attributes, and representative bone and tissue samples (femur, rib, phalange) were collected for nuclear DNA testing. The general condition of the body was good with some tissues intact; the body was not fully skeletonized. No dental records or wedding ring was present for identification. DNA reference samples (buccal swabs) were also collected from family members to reconstruct the deceased's DNA profile for comparison. Mitochondrial DNA testing was not possible for this case due to no living maternal relatives.

Multiple bone samples were cleaned with 10% sodium hypochlorite and bone powder was removed with a Dremel drill from the central medullary portion of 3-day-old, oven dried bones. DNA extractions were performed using an Invisorb Forensic Kit (Invitek GmbH, Berlin, Germany) that specifies a procedure for DNA purification from ancient bone material. This procedure is based on bead capture technology that increases the recovery of DNA and reduces carry over of PCR inhibitors from the body decomposition process. PCR amplification was performed using a Profiler Plus™ (Applied Biosystems, Inc., Foster City, CA) human identification kit and DNA detection was performed on an ABI 310 DNA Sequencer®. A partial DNA profile was obtained from one of 10 DNA extractions; the successful sample originated from a rib bone. A low copy number approach (multiple PCR amplifications of the same DNA extract) was used to maximize the confidence in the DNA markers identified from the bone. After reconstruction of the deceased's DNA profile from family reference samples, it was concluded that the human remains did indeed belong to that family group.

The full case study will be presented as an example of a relatively quick DNA extraction process and low copy number PCR approach that was successfully used on challenging samples for human identification.

Bone, DNA, Forensic

B63 Sodium Phosphate Enhanced DNA Extraction From Bone

Mark T. Osterlund, PhD, and Erica M. Shepard, MS, FBI Laboratory Division, Visiting Scientist Program, Building 12, FBI Academy, Quantico, VA 22135; and Kerri A. Dugan, PhD, FBI Laboratory Division, Counterterrorism Forensic Science Research Unit, Building 12, FBI Academy, Quantico, VA 22135*

After attending this presentation, attendees will have learned a rapid alternative method to extract DNA from bone.

This presentation will impact the forensic community and/or humanity by demonstrating improved methods of dealing with the calcified matrix from compact bone during DNA extraction will be useful for forensic practitioners in human identification.

The forensic community frequently uses bone tissue for DNA typing the remains of missing persons, crime victims, and victims of mass disasters (Hochmeister et al. 1991, Hagelberg et al. 1991, Gill et

al.1994, Holland et al. 2003). Extraction of DNA from bone can be difficult due to a compact calcified matrix combined with a relatively low cellular content. Consequently, improved methods of dealing with bones' calcified matrix during DNA extraction should prove beneficial to assist forensic practitioners in human identification.

The predominant inorganic component of bone is hydroxyapatite (HA), a stable calcium phosphate compound ($[Ca_5(PO_4)_3OH]_2$) that is the major contributor to bones' structure and compact matrix. Nucleic acids have a strong affinity for HA that has been utilized for chromatographic separation and purification of nucleic acids (Bernardi 1965). Since DNA likely binds endogenous HA of bone following cell lysis, several current forensic protocols include extensive incubations in a high concentration of EDTA to alter this interaction (Hagelberg et al. 1991). While this process improves the DNA recovery in many cases, decalcification extends the extraction protocol and requires the removal of EDTA, a potent PCR inhibitor, prior to PCR amplification. With this in mind, alternative methods to disrupt the interaction between DNA and HA during the extraction step were explored.

The affinity between DNA and HA can be regulated using various phosphate buffers (Sambrook and Russell 2001). Historically, the manipulation of phosphate concentrations has exploited HA as a method of purifying and separating DNA from various samples. Studies from the anthropological community first applied this technique to DNA extraction by using phosphate buffers on prehistoric bone (Persson 1992). This was later supported by a comparative study of several extraction buffers, in which phosphate buffer was the most successful in extracting DNA from both synthetic HA and bovine bone samples (Götherstrom & Lidén 1996).

In this study, a faster, alternative method of disrupting the interaction between DNA and HA was pursued. By incorporating high concentrations of sodium phosphate (NaP) in the extraction buffer, the binding of DNA to the endogenous HA of bone may be blocked or reversed. Preliminary work showed that this extraction method is suitable for downstream mitochondrial DNA (mtDNA) analyses and can be completed in as little as two hours. More in depth studies included optimization of NaP concentration and DNA purification conditions. Depending on the bone, this extraction method can yield a 2,000-fold increase in mtDNA copy number concentration when compared to protocols that do not disrupt the HA-DNA interaction. In addition, initial work indicates that STR profiles can be obtained from these extracts by optimizing PCR conditions. In summary, application of this protocol to forensic science has the potential to dramatically reduce the amount of time required to isolate DNA from bone samples, increase mtDNA yields, and possibly improve chances of obtaining STRs from skeletal remains.

mtDNA, Extraction, Skeletal Remains

B64 Simplified Low Copy Number (LCN) DNA Analysis by Post PCR Purification

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After attending this presentation, attendees will understand the effect of various post PCR purification methods on the sensitivity of fluophore-based allelic detection using capillary electrophoresis; learn how to perform low copy number DNA analysis (< 100 pg) using 28 cycle amplification; and learn how to enhance weak DNA samples (> 100 pg) to obtain full DNA profiles.

This presentation will impact the forensic community and/or humanity by demonstrating methods that will allow for genetic information to be obtained from forensic DNA samples that previously would not have been detected due to low DNA template. An immediate

application can be made in forensic case working laboratories for the enhancement of weak DNA samples. In addition, a bona fide alternative to LCN analysis is described which may be utilized in lieu of or in conjunction with increased amplification cycle LCN analysis. This method may prove to have greater allele fidelity than increased amplification cycle as indicated by negative amplification controls.

Frequently evidentiary items contain an insufficient quantity of DNA to obtain complete or even partial DNA profiles using standard forensic genotyping techniques. This presentation explores the effect of increasing PCR sensitivity without increased amplification cycles. Standard 28 cycle amplification is followed by purification of the PCR product. Un-reacted reaction components are removed from the amplification mix prior to capillary electrophoresis thus preventing their competition with amplicons during electrokinetic injection. Here, various methods of post PCR purification are evaluated for their effects on the sensitivity of fluophore-based allelic detection. A method of post PCR purification is described which increases the sensitivity of standard 28 cycle PCR such that weak samples (> 100 pg) can be enhanced to obtain full DNA profiles. With minor modification this method of post PCR amplification increases the sensitivity of standard 28 cycle amplification such that low copy number DNA templates (< 100 pg DNA) can be analyzed. Full profiles were consistently obtained with as little as 20 pg template DNA and significant allelic data was generated with as little as 5 to 10 pg DNA without increased cycle number. In mock case type samples with dermal ridge fingerprints, genetic profiles were obtained by amplification with 28 cycles followed by post-PCR purification whereas no profiles were obtained without purification of the PCR product. Allele drop out, increased stutter, and sporadic contamination typical of LCN analysis were observed; however no contamination was observed in negative amplification controls. The effects of low copy number DNA analysis by post PCR purification on stutter and heterozygote peak imbalance are also described. In addition, guidelines for the application of post PCR purification to amplified DNA samples are presented.

PCR Purification, Low Copy Number, MinElute

B65 Purification of Low Quality Human Remains Extract Using Centri•Sep Columns

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The goal of this presentation is to present to the forensic community a method for the removal of PCR inhibitors and other low molecular weight components from challenged human bone DNA extracts. The relative ease and efficacy of this technique facilitates incorporation into laboratory procedures for achieving reportable STR profiles from low quality samples.

When utilizing DNA techniques to identify human remains from mass disasters, the forensic analyst is exposed to many challenges; foremost of which is the compromised quality of recovered samples. The bones of mass disaster victims have often been subjected to various destructive environmental conditions causing degradation of nuclear DNA and introduction of PCR inhibitors. Since success in achieving complete STR profiles is severely affected by both degradation and inhibition, amplification may yield only alleles from the smaller STR loci if any loci are detectable at all. Partial profiles can pose a problem in creating statistically significant matches for identification purposes. This presentation will impact the forensic community and/or humanity by demonstrating how the use of Centri•Sep columns has proven

successful in the purification of inhibited and degraded human remains samples, resulting in reportable profiles for samples that otherwise would have failed to yield a result.

To assist in identification efforts, The Bode Technology Group has incorporated the use of Centri?Sep columns (Princeton Separations) for pre-PCR purification of challenged DNA extracts from human bones. Centri?Sep allows for equilibration of multiplex STR profiles by averting preferential primer binding of smaller oligonucleotides and avoiding concentration of inhibitors. Although Centri?Sep columns were originally designed for post-sequencing dye terminator clean-up, the column's ability to remove 98% of salts and low-molecular-weight impurities increases the ratio of larger DNA fragments. The hydrated gel matrix in the column efficiently separates large molecules from small molecules via size exclusion chromatography. During this process, the centrifugal force promotes flow of the extract through a stationary matrix where some molecules will be retained within extremely small porous beads; while larger molecules consequently filtrate through the column to become the eluant. Use of Centri?Sep columns has proven successful in the purification of inhibited and degraded human remains samples, resulting in reportable profiles for samples that otherwise would have failed to yield a result.

The Bode Technology Group will present several examples of samples that yielded imbalanced and partial profiles when first amplified with the Applied Biosystems AmpF/STR® Identifier® Kit (targeting between 1.0-1.5 ng template per reaction), yet after purification with the Centri?Sep column, high partial or full profiles were obtained under similar amplification conditions. Additionally, the electropherograms presented will depict cleaner profiles consisting of greater balance among all loci.

PCR Inhibitors, Bone Samples, Centri?Sep Columns

B66 Low Copy Number Methodologies: A Comparison Study of Low Copy Number PCR and Multiple Displacement Amplification

Denise N. Rodier, MS, Michelle D. Bonnette, BS, and Tracey Dawson Cruz, PhD, Virginia Commonwealth University, Department of Forensic Science, 1000 West Cary Street, PO Box 842012, Richmond, VA 23284*

After attending this presentation, attendees will understand the benefits and drawbacks of multiple displacement amplification and low copy number PCR as related to forensic DNA analysis of low quantity/low quality biological evidence.

This presentation will impact the forensic community and/or humanity by providing insight for further research avenues towards attaining a dependable method for analyzing degraded, aged, or otherwise limited biological evidence samples.

The use of DNA amplification kits has become commonplace in forensic labs for DNA analysis of short tandem repeat (STR) profiles. However, these kits require strict adherence to the suggested input quantities of DNA (1-2.5 ng) to yield accurate and reliable results. Oftentimes, the evidence available for a given forensic case falls below this recommended input range. Therefore, researchers have begun to investigate various methods of whole genome amplification (WGA) as a means of increasing the initial quantity of DNA available, to levels

adequate for the downstream application of STR profiling using the polymerase chain reaction (PCR). This study compares one such method of WGA, multiple displacement amplification (MDA), to low copy number PCR (LCN) to determine their effectiveness when working with low copy number DNA samples. DNA was extracted from buccal swabs and diluted to 0.25 ng, 0.125 ng, 0.062 ng, 0.031 ng, 0.016 ng, and 0.0075 ng concentrations for use in this comparison study. MDA was performed according to the GenomiPhi™ DNA Amplification kit guidelines. The total DNA recovered was then quantified using the ABI Quantifiler™ kit with the ABI Prism® 7000 for real-time PCR analysis. In addition, all post-MDA DNA was visualized by agarose gel electrophoresis to determine the size of the DNA fragments obtained. The samples were then subjected to an STR amplification reaction with the AmpF/STR Profiler Plus™ kit. The LCN STR amplification was performed using the ABI Profiler Plus™ kit but with an increased cycle number (from the traditional 28 cycles to 34 cycles). STR products were separated and detected by capillary electrophoresis (CE) using the ABI Prism® 3100-*Avant* Genetic Analyzer, and analyzed with either ABI Prism® GeneScan® Analysis Software v 3.7.1 and Genotyper® Software v 3.7 or Genemapper™ ID Software v 3.1. STR success rate and quality was compared between the two methods.

DNA yields after MDA were variable, showing no obvious trend and generating between 7.5 and 6734-fold increases in total DNA. Post-MDA fragments were consistently >40kb in size for all samples tested. It should also be noted that negative controls also consistently showed DNA fragments when visualized on agarose gels. As for the STR success rate of samples after MDA, there was a trend of decreasing locus success with decreasing input DNA quantities (from 88.3% success at 0.25 ng inputs to 24% at 0.016 ng inputs); however, high amounts of interlocus and intralocus peak imbalance were observed. Additionally, extra alleles were seen in the MDA products after STR amplification, with a greater number of alleles per locus in the higher input DNA samples (with averages of up to four alleles per locus for 0.25 ng inputs). Alleles were also seen in the negative control MDA samples but were not consistent with the positive control profile or the profile of the laboratory analyst. STR locus success for the LCN PCR samples was significantly improved to that of the MDA samples, showing an 80% success rate when >0.031 ng input DNA was used. Unfortunately, heterozygote peak balance greater than 50% was only seen with the 0.25 ng and 0.125 ng input samples subjected to LCN PCR, but peak imbalance was somewhat improved when injection time on the CE was decreased from five seconds to two seconds. Additional alleles were also seen in STR profiles when the LCN PCR technique was used. Again more typed alleles were noted in the higher input samples, although decreasing injection time to two seconds reduced the number of extraneous alleles present in the STR profiles. This study shows that although both MDA and LCN PCR show some improvement for analyzing low copy number DNA samples both would require extensive optimization before they could be readily accepted practices for reliably obtaining STR profiles in the forensic community. Furthermore, while the LCN PCR approach shows a greater success rate for obtaining the expected alleles in a profile, the occurrence of extraneous alleles and stochastic effects will likely hinder its immediate implementation as a low copy number analysis method for most forensic labs. These findings will impact the forensic community by providing insight for further research avenues towards attaining a dependable method for analyzing degraded, aged, or otherwise limited biological evidence samples.

Forensic DNA Analysis, Low Copy Number PCR, Multiple Displacement Amplification

B67 Sequencing of Highly Degraded, Ancient DNA From *Metasequoia glyptostroboides*

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After attending this presentation, attendees will understand the endeavors that must be considered when working with an ancient DNA sample that is in low copy number and highly degraded.

This presentation will impact the forensic community and/or humanity by expanding on low copy number applications and devising methods that can be applied to highly degraded or low copy number forensic casework samples and substrates where nuclear DNA is not able to be obtained.

Metasequoia glyptostroboides is a conifer that was prevalent in the middle-Eocene-age forests of the Napartulik, Axel Heiberg Island, within the Canadian High Arctic. These forests have been dated to be 45 million years old and today exist as mummifications. Previously, chloroplasts of *Metasequoia glyptostroboides* were found to be intact by transmission electron microscopy. Chloroplasts have their own DNA that is found in multiple copies in the cell and are more likely to be retrieved than nuclear DNA in an ancient and/or degraded sample. Additionally, plant tissues are inherently challenging as they are considerably richer in primary or secondary metabolites (than animal tissues) and these can be potential inhibitors of PCR. Due to the conservation of the arrangement of many genes in the chloroplast DNA, such as tRNA genes, numerous "universal" primers have been designed and are available for use in molecular evolutionary studies.

This work attempts to sequence a non-coding tRNA intergenic spacer region of *Metasequoia glyptostroboides*. To date, neither animal nor plant sequence data has been reported from samples older than 18 million years old. Three different extraction methods were used for DNA extraction for the ancient samples, fresh Dogwood samples (positive control), and reagent blanks (negative control) including organic, Qiagen DNeasy Plant Mini Kit, and cetyltrimethylammonium bromide (CTAB) with polyvinyl pyrrolidone (PVP). Yield gels were run to gauge extraction success. All samples were amplified using the conserved primer pair *trnL-F*, which produces an expected product size of 289bp in *Metasequoia glyptostroboides*. This primer pair is between the tRNA genes *trnL* and *trnF* that code for Leucine and Phenylalanine, respectively. Product gels were run to gauge success of PCR amplification and product cleanup was performed using Rapid PCR Purification Systems. Cycle sequence reactions were performed using the ABI Big Dye Terminator v.3.1 Cycle Sequencing Kit and DTR Gel Filtration Cartridges were used for cycle sequencing cleanup. Separation and detection was performed using the ABI 3100-Avant Genetic Analyzer. ABI Sequencing Software v.5.1.1 and Sequencher v. 4.1.4FB19 were used for analysis. Sequencing success was compared between the three different extraction methods to determine which, if any, is most appropriate for the ancient *Metasequoia* samples. Sequencing success was determined by contiguous base pair length of the sequence obtained, if any. Extracts were then subjected to Amersham Biosciences Templiphi 100 kit for whole genome amplification (pre- tRNA amplification) to attempt to increase sequencing success.

Sequence data was obtained for positive controls extracted by the organic and CTAB methods (365 bp and 394 bp length of read, respectively). No product was observed nor was sequence data obtained from the ancient *Metasequoia* samples. However, after whole genome

amplification, yield gels showed DNA smears for *Metasequoia* extracts in each of the extraction methods. Unfortunately, these samples failed to produce the expected band after tRNA amplification.

Future direction of this work includes amplifying *Metasequoia* extracts from the three extraction methods with other conserved primer pairs to explore sequence data in other regions of the chloroplast genome. Whole genome amplification will continue to be explored as a pre-amplification step in an attempt to increase sequencing success for this highly degraded ancient DNA sample.

Degraded DNA, Ancient DNA, LCN

B68 Integrated DNA Extraction and PCR Amplification of STRs: Interfacing Microfluidic Devices With Current Methodologies and Conventional Instrumentation

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The goal of this research project is to integrate DNA extraction and amplification for forensic genetic analysis in microfluidic systems in a manner that interfaces with conventional methods and laboratory instrumentation.

This presentation will impact the forensic community and/or humanity by detailing the interfacing of microfluidic technology with conventional techniques and instrumentation for forensic genetic analysis, a possible stepping stone towards the inclusion of totally automated microfluidic systems in forensic casework analysis.

Solid-phase extraction (SPE), PCR amplification, and high-resolution separations of PCR-amplified DNA from a variety of clinical, biohazardous, and forensically-significant samples are now readily carried out in microfluidic systems. With successful microchip adaptation of these individual processes becoming more commonplace and now being evaluated in forensic labs, research focus has shifted towards integration of these methods and the creation of multi-process, stand-alone devices with full-genetic profiling capabilities¹. Integrated microfluidic systems offer an analysis platform capable of reducing the time, reagents, and sample necessary to perform many forensic and clinical analyses; however, there are many challenges associated with integrating multiple analysis steps on-chip for forensic analysis. Of particular concern is the difficulty of integrating solid phase DNA purification with PCR amplification, due primarily to the inherent incompatibility of the SPE reagents (guanidine and isopropanol) with the amplification reaction². This is complicated by the need to carry out complex, multiplexed PCR amplifications using established commercially-available reagents and protocols. In addition, as the community looks to incorporate new microfluidic technology in crime labs, the transition from current bench-top systems towards microchip platforms could prove problematic, as the cost of this shift to unvalidated methods and instrumentation may quickly become prohibitive. In order to facilitate this transition, the fusing of already validated and established techniques/instrumentation with microfluidic systems provides a stepping stone towards the inclusion of stand-alone microfluidic total analysis systems in forensic casework analysis. By improving the timeliness and cost-effectiveness of analysis without requiring a prohibitively expensive overhaul of equipment and instrumentation, hybrid systems that effectively utilize existing technology, while exploiting microfluidic components become an attractive solution to this problem.

The research presented here describes an advancement that allows for integrated sample preparation for forensic applications to be carried

out in a valveless microfluidic device using conventional bench-top instrumentation. With a focus on the fabrication and implementation of integrated glass microdevices for extraction and PCR amplification of STRs, these valveless devices are interfaced with conventional technology. DNA extraction is accomplished using a simple syringe pump and microchip-contained silica solid phase, followed by on-chip PCR amplification using a common bench-top thermocycler to accomplish amplification of STRs in ~500 nL with standard commercially-available amplification kits. Sample removed from the device is demonstrated to be amenable to analysis on standard capillary electrophoresis instrumentation. Methods for integrated DNA extraction and PCR amplification of STRs from forensically-relevant samples, with this commonly-available instrumentation are discussed. The work reported here highlights the feasibility of using a microdevice for sequential DNA extraction and PCR amplification on the same device, by interfacing the low-volume, closed-system, cost-effective micro-sample processor with currently-available benchtop instrumentation, circumventing the expense associated with the instrumentation that would be needed for new analysis platform. This work highlights the development of an integrated microfluidic extraction and amplification device that could be seamlessly assimilated into crime laboratories without the addition of costly instrumentation, improving forensic genetic analysis and providing a more facile transition to fully-automated genetic analysis systems.

References:

¹ Easley, CJ, Karlinsey, JM, Bienvenue, J.M., Legendre, L.A., Roper, M.G., Feldman, SH, Hughes, MA, Hewlett, EL, Merkel, TJ, Ferrance, J.P. and Landers, J.P. "A Fully-Integrated Microfluidic Genetic Analysis System with Sample in-Answer out Capability." PNAS (in revision).

² Lindsay A. Legendre*, Joan M. Bienvenue*, Michael G. Roper, Jerome P. Ferrance, James P. Landers. 2006. "A Valveless Microfluidic Sample Preparation Device for DNA Extraction and Amplification Using Conventional Instrumentation". *Anal Chem.* 5(78): 1444-51.

DNA Extraction, PCR, Microchip

B69 Microchip-Based Solid Phase Purification of RNA

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The goal of this research project is the purification of RNA from crude samples using microfluidic devices.

This presentation will impact the forensic community and/or humanity by presenting research which represents the first demonstration of RNA purification and total nucleic acid isolation in a microfluidic device, which may positively impact the ability to identify body fluids for forensic analysis.

As microfluidic technology continues to evolve for both forensic and clinical applications, microdevices have increasing appeal as an alternative platform to costly, time- and reagent-consuming analyses. PCR amplification and DNA separations are now accomplished with reduced volumes/analysis times,¹ and the application/testing of these devices in forensic laboratories is now underway. In addition, sample preparatory steps, such as DNA extraction and purification, have also been miniaturized, again with a concomitant reduction in sample size, reagents consumed, and time.² Glass microdevices packed with solid phases such as silica beads, sol-gel immobilized silica beads, or sol-gels

alone have demonstrated utility as potentially low-cost alternatives for highly efficient and reproducible extraction of DNA.³ Micro solid phase extraction (μ SPE) provides the benefits of reproducibility and high extraction efficiency, while also yielding highly purified, PCR-ready DNA in reasonably small volumes. While much attention has been focused on the development of microfluidic systems for DNA purification, little research effort has been directed towards the development of robust systems for RNA isolation and with the recent development of mRNA expression analysis systems for body fluid identification by other research groups,⁴ the ability to effectively purify RNA from crude samples becomes a necessity. Isolation and purification of RNA, without compromising the integrity of the DNA present in samples, however, has proven challenging. Current methodologies often require organic extractions with time- and reagent-consuming incubation and centrifugation steps not to mention multiple points where contamination with nucleases is a possibility. Thus, closed microfluidic systems capable of rapid, sensitive, total nucleic acid isolation become a logical and potentially important solution. Silica-based SPE methods are not only effective for DNA purification, but also RNA purification and in self-contained microdevices provide a tremendous advantage for forensic analysis by inherently removing many potential sources of contamination and degradation of nucleic acids by nucleases. As a result, these new methods can provide high efficiency, high purity extractions (free from PCR inhibitors and nucleases) resulting in both the recovery and concentration of small masses of DNA and RNA from complex and potentially contaminated mixtures for a complete forensic genetic analysis.

The research presented here describes a microchip-based method being developed for the purification of total nucleic acids from biological samples. This method, designed to co-purify DNA and RNA from multiple biological sources, utilizes a previously described silica-based solid phase extraction for the isolation of nucleic acids. A device designed to accomplish this purification is presented along with a method for simultaneous recovery of DNA and RNA fractions in purified and concentrated form. Using commercially-available nucleic acid quantitation kits, DNA and RNA are co-purified and quantified from biological samples. In addition, preliminary studies describing the capacity and extraction efficiencies with these devices are reported. Elution profiles detailing the recovery of RNA and DNA from biological samples are also presented, along with the results of downstream processing of these purified nucleic acids via PCR and RT-PCR. The advantages of microfluidic systems for nucleic acid purification will be highlighted, with focus on the results presented, which represent the first demonstration of RNA purification and total nucleic acid isolation in a microfluidic device.

References:

¹ Easley, CJ, Karlinsey, JM, Landers, JP. 2006. "On-chip pressure injection for integration of infrared-mediated DNA amplification with electrophoretic separation". (Journal Cover) *Lab Chip.* May;6(5):601-610.

² Easley, CJ, Karlinsey, JM, Bienvenue, J.M., Legendre, L.A., Roper, M.G., Feldman, SH, Hughes, MA, Hewlett, EL, Merkel, TJ, Ferrance, J.P. and Landers, J.P. "A Fully-Integrated Microfluidic Genetic Analysis System with Sample in-Answer out Capability." PNAS (in revision).

³ Bienvenue, JM, Duncalf N, Marchiarullo, D, Ferrance, JP, and Landers, JP. 2006. "Microscale Cell Lysis and DNA Extraction of Sperm Cells for Forensic Analysis," *J. Forensic Sciences.* *J. Forensic Sciences.* 2(51): 266-73.

⁴ Juusola, J, Ballantyne, J. 2005. "Multiplex mRNA Profiling for the Identification of Body Fluids." *For. Science International.* 152: 1-12.

RNA, Extraction, Microchip

B70 Acoustic Differential Extraction for the Analysis of Sexual Assault Evidence on Microdevices

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The goal of this poster is to introduce a means of improving the analysis of sexual assault evidence using a novel approach for obtaining highly-enriched male and female fractions. In addition, the audience will be introduced to the use of microchip technology for forensic DNA analysis.

This presentation will impact the forensic community and/or humanity by demonstrating an acoustic differential extraction method presented has the potential to significantly alter the means by which sexual assault evidence is processed in crime laboratories. This method is one step of a totally integrated, automated microchip format for forensic DNA analysis.

DNA analysis of sexual assault evidence requires separation of the male and female fractions to aid in obtaining STR profiles of both individuals. Conventionally, this is accomplished using the differential extraction method,¹ in which the differential stability of the nuclear membrane of each cell type is exploited. That is, vaginal epithelial cells are susceptible to lysis under 'mild' extraction conditions, whereas sperm cells require the reduction of the disulfide bonds in the nuclear membrane to efficiently release sperm cell DNA. Using this differential lysis, sperm cells are then separated from epithelial cell DNA using centrifugation and multiple wash steps to yield separate male and female fractions. This method, however, suffers from extensive handling by analysts, often poor efficiency separation (i.e., significant female carryover into the male fraction), and lack of automation.

An alternative to the conventional method, termed acoustic differential extraction, has been developed for isolation of the male and female fractions from sexual assault evidence to address the shortcomings of the conventional methodology. After elution of the biological material from a vaginal swab under 'mild' lysis conditions, this method separates sperm cells from the mixture of epithelial cell lysate (free female DNA) and sperm cells. The separation of the male and female fractions is carried out in a valveless microdevice, consisting of a printed circuit board layer (containing piezoelectric transducers to generate the acoustics) and a glass layer containing the microchannel structure. Upon application of electrical signal to the transducers, a standing ultrasonic acoustic wave is set up in the microchannel, resulting in a pressure-minimum in the center of the channel. The physical characteristics of a given cell or particle determine whether, or to what extent, it will be trapped in the acoustic wave.² In this method, the system has been optimized to trap sperm cells, whereas free DNA (primarily from the epithelial cell lysate) will not be trapped. Isolation of the highly-enriched male and female fractions is completed using precise fluidic control³ that exploits laminar flow valving, negating any need for active valving on the microdevice.

Upon activation of the ultrasound, the biological sample is infused into the microdevice and sperm cells are trapped in the microchannel above the transducer. The free DNA, unretained in the acoustic trap, is directed to the female DNA outlet. The immobilized sperm cells, trapped in a monolayer in 3D fluidic space in the microchannel, are washed with buffer to remove any free DNA that was inadvertently trapped. With laminar flow valving, the flow is re-directed to the male outlet and the ultrasound silenced, resulting in release of the sperm cells

from the acoustic trap, movement into the male outlet DNA outlet and subsequent isolation of the male fraction.

Product from the acoustic differential extraction microdevice, both male and female fractions, was collected and analyzed off-chip to show sample purity. DNA from the isolated cells was extracted using a commercial DNA extraction kit and analyzed with a duplex quantitative PCR assay⁴ to determine the percent of male and female DNA in each fraction. In addition, STR amplification was utilized to show efficiency of separation.

References:

- ¹ Gill, P.; Jeffreys, A. J.; Werrett, D. J. *Nature* 1985, 318, 577-579.
- ² Gorkov, L. *Sov. Phys. Doklady* 1962, 6, 773-775.
- ³ Blankenstein, G., Scampavia, L., Branebjerg J, Larsen UD, and Ruzicka J. *Proceedings of the 2nd International Symposium on Miniaturized Total Analysis Systems mTAS96* 1996, 82-84.
- ⁴ Horsman, K. M.; Hickey, J. A.; Cotton, R. W.; Landers, J. P.; Maddox, L. O. *Journal of Forensic Sciences*. 2006, 51, 758-765.

Acoustic Trapping, Differential Extraction, Microchip Technology

B71 Development of a DNA Screening Method Using a Portable Microfluidics System and the D1S80 VNTR Locus

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After attending this presentation, attendees will understand how to perform DNA screening using a portable microfluidics system (Agilent 2100) and the D1S80 VNTR locus with amelogenin

This presentation will impact the forensic community and/or humanity by demonstrating how small microfluidic devices can be used as rapid and portable methods for the analysis of DNA.

The goal of this research is to develop a fast and portable screening method for human identification for DNA typing in remote areas or in situations involving mass disasters. In such situations, lightweight, portable genetic analyzers are necessary. Due to its small size and relative ease of use, the Agilent Bioanalyzer 2100 was chosen as a suitable instrument for this task. This system is an automated microfluidics system which uses capillary electrophoresis in a chip-based format. It contains 16 sample inlet channels coupled to a single separation channel with fluorescent detection. Operation occurs with minimal user interaction, and the chips are simply disposed of following each analysis. The system is currently being used in several types of biological analyses, including fragment analysis of double stranded DNA, and quantification and sizing of DNA. Individual sample runs typically take less than two minutes, and overall run times are about 30 minutes. Maintenance and buffer requirements of the instrument are minimal when compared to the larger genetic analyzers due to the disposable design and low volume of the microfluidic chips.

However, due to its lower resolution when compared to larger CE systems, the Bioanalyzer is unsuitable for analysis of small STR loci where resolution of one or two base pairs is required. This problem can be alleviated through the use of a DNA marker with larger simple repeat units. D1S80 is such a marker.

The characteristics of D1S80 make it a very useful marker for forensic DNA profile analysis. D1S80 has a basic repeat unit of 16 bp. Most individuals have alleles containing between 14 to 40 tandem repeats, with a size range of 224 to 640 bases. Due to the high number of alleles, it has a relatively high discriminatory power for a single locus. Amplification of D1S80 has been extensively validated for genetic

typing used in forensic casework including extraction, quantification, amplification, and electrophoresis. The initial description of the D1S80 locus was published in 1988¹ and the locus can be multiplexed with amelogenin for sex typing².

In this presentation initial efforts in developing a separation of D1S80 using this device will be described. In particular, the separation efficiency and reproducibility of the system will be discussed. Efforts to develop and produce allelic ladders and to multiplex the system with amelogenin will be discussed and validation results from a set of population samples will be described.

¹ Nakamura Y, Carlson M, Krapcho V, White R. Isolation and mapping of a polymorphic DNA sequence (pMCT118) on chromosome 1p (D1S80). *Nucleic Acids Res.* 1988;16:9364.

² Isenberg AR, McCord BR, Koons BW et al. DNA typing of a polymerase chain reaction amplified D1S80/amelogenin multiplex using capillary electrophoresis and a mixed entangled polymer matrix. *Electrophoresis.* 1996;17(9):1505-1511.

D1S80, Microfluidic, DNA

B72 DNA Purification From Forensic Samples Using the BioRobot® M48

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The goal of this presentation is to educate investigators and analysts about the applicability of medium throughput automation for extraction of nucleic acid evidence from a wide range of difficult case work sample types.

This presentation will impact the forensic community and/or humanity by enabling forensic investigators to process case evidence with higher accuracy, reproducibility, greater consistency, and standardization. Data will be presented.

Optimized protocols for automated extraction of genomic DNA from forensic reference and casework samples have been developed. 6–48 samples can be processed in parallel, giving efficient processing of forensic samples and optimized workflow with minimal human contact.

Materials and Methods: The BioRobot® M48 system provides fully automated purification of DNA using silica-coated magnetic particles. The process does not involve any time consuming centrifugation steps. The easy-to-use workstation allows purification of 6–48 samples in a single run. Between processing runs, the worktable can be decontaminated using an integrated UV lamp to reduce the chances of environmental contamination. For this study DNA was purified from various forensic samples or from diluted DNA using fully automated protocols according to the new *MagAttract DNA Mini M48 Handbook* (www.qiagen.com/goto/M48ForensicHB).

Results and Discussion: Genomic DNA purification protocols were optimized for use with forensic samples. Fine tuning of bead concentrations and washing procedures lead to higher peaks and improved signal-to-noise ratios. This enabled highly sensitive detection and high performance in downstream applications. The application has been tested with difficult sample types known to contain high concentrations of inhibitors, such as cigarette butts. STR analysis shows higher peaks for more sensitive detection.

In addition to the standard trace protocol, a new, fully automated “tip dance” protocol was established, where the filter-tip moves back-and-forth relative to the worktable platform while pipetting. This enabled processing of solid materials, such as swabs, fabrics, blood discs, or cigarette butts, directly in the sample tube. There was no need for prior centrifugation to remove solid materials that could clog the tip. The “tip dance” protocol simplifies handling and, in some cases, increases DNA yield with more efficient extraction of the sample and minimal human contact with the sample.

New large volume protocols allow processing of sample volumes up to 500µl to enable higher yields and retrieval of more concentrated DNA for greater sensitivity in downstream applications.

A normalization protocol was developed where DNA yields could efficiently be limited to 150–250 ng by a precise control of the surface area provided in the DNA binding step. This protocol enables subsequent genetic analysis without the need to measure or adjust DNA concentration. This application is sought to be particularly useful for database sample preparation.

Conclusions: Forensic sample preparation on the BioRobot M48® system provides:

- **Efficient yields for sensitive analyses** — from casework samples
- **Normalized yields** – from database samples
- **High signal-to-noise ratios** — for sensitive downstream detection assays
- **Easy handling** — swabs, blood discs, cigarette butts, and other solid samples can be processed directly on the workstation
- **Newly optimized protocols** — including larger starting volumes (500 µl) for increased sensitivity on dilute samples and normalization for uniform yields

Automation, Nucleic Acid Extraction, Casework Evidence

B73 Microfabricated Capillary Array Electrophoresis (µCAE) STR Profiling in a Forensic Laboratory

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After attending this presentation, attendees will have learned about a microfabricated device which may replace conventional capillary electrophoresis with a faster, smaller, cheaper high throughput system.

This presentation will impact the forensic community and/or humanity by presenting data produced by forensic scientists using a prototype microcapillary chip system for capillary electrophoresis. This system is small, fast, high throughput and will likely be much cheaper to operate than the conventional capillary systems currently available.

The Berkeley Microfabricated Capillary Electrophoresis (µCAE) device has previously been reported to provide high quality STR profiling using both simulated and non-probative forensic samples.¹ As an extension of that work, a pre-commercial prototype instrument has been set up at the Virginia Department of Forensic Science (VDFS) for testing in a forensic laboratory. The first step in the process was for forensic DNA scientists to master the operation of the instrument. Upon completion of instrumentation set-up and a series of calibration and implementation runs, single source samples, amplified with PowerPlex® 16, have been successfully electrophoresed and analyzed. PowerPlex® 16 STR profiles obtained are being compared to the profiles obtained for the same amplified samples using the ABI 310 Genetic Analyzer® for concordance evaluation. Also plan necessary tests Profiler Plus™ amplified DNA extracts. Experiments are underway to reproduce the work performed at the Mathies' laboratory at the University of California, Berkeley, which included mixture, sensitivity, database, and non-probative sample analysis, but also to assess chip instrument performance using additional measures. Resolution measurements beyond those previously published are being performed and precision data are being collected. Experiments designed

to assess whether any capillary cross-talk occurs among the 96 capillaries are being performed. Moreover, performance enhancement measures will be tested and pursued.

Successful operation of the μ CAE demonstrates the capacity of this technology to be transported out of the research venue and into a practitioner forensic laboratory. Not only does this demonstrate the feasibility of the paradigm shift from large capillary systems to a microfluidic system capable of electrophoresing and capturing the STR data for 96 samples simultaneously in less than 30 minutes, it demonstrates that this technological advance can be mastered by the forensic scientist.

Reference:

¹ Yeung, S, Greenspoon, S, McGuckian, A, Crouse, C et al. Rapid and High-Throughput Forensic Short Tandem Repeat Typing Using a 96-Lane Microfabricated Capillary Array Electrophoresis Microdevice. *J Forensic Sci* 2006;51(4):740-747.

STR, PowerPlex 16, Microcapillary Electrophoresis

B74 On-Site Forensic Analyses Using Capillary Electrophoresis On-A-Chip

Dan G Sykes, PhD, and Frances A Carroll, BSc, Forensic Science Program, 107 Whitmore Lab, Pennsylvania State University, University Park, Pennsylvania 16802*

After attending this presentation, attendees will learn about current efforts to develop field-portable cost-effective, quantitative, and defensible analytical methods for screening a wide array of substances/materials at crime scenes

This presentation will impact the forensic community and/or humanity by informing the forensic science community of the current research to develop a rapid, cost-effective, quantitative, and defensible analytical method for screening a wide array of substances/materials at crime scenes. Deployment of the CE-Chip can aid in on-site determination of the evidentiary value of a substance thus reducing, or eliminating, the collection and submission of unnecessary samples. The device can also be used within local police facilities for preliminary and follow-up analysis thus reducing the amount of evidence to be submitted to a crime lab facility.

The presentation describes research towards the development of a portable capillary electrophoresis (CE-Chip) system that employs electroanalytical, laser-induced fluorescence and absorbance detection for the analysis of a wide-range of analytes of forensic interest. Over the past few years, there has been a sustained effort to develop reliable portable systems for the field-based detection of drugs, explosive materials, and other agents. Capillary electrophoresis is a mature technology with many advantages over ion-mobility spectroscopy and gas and liquid chromatography methods including greater efficiency, analysis times on the order of seconds to just a few minutes, and sample volumes on the order of pico- to nanoliters.

A central goal of the research is to develop a rapid, cost-effective, quantitative, and defensible analytical method for screening a wide array of substances/materials at crime scenes. Deployment of the CE-Chip can aid in on-site determination of the evidentiary value of a substance thus reducing, or eliminating, the collection, and submission of unnecessary samples. The device can also be used within local police facilities for preliminary and follow-up analysis thus reducing the amount of evidence to be submitted to a crime lab facility. Capillary electrophoresis can provide the same information as gas chromatography-mass spectroscopy, Fourier-transform spectroscopy, and scanning electron microscopy-energy dispersive X-Ray analytical methods for a fraction of the cost – in time and money – or can aid in the determination of evidence to be submitted for confirmatory tests using the above techniques.

The prototype system uses glass chips with outer dimensions of 45x15x1.8 mm. The width and depth of the channels between reservoirs are 50 μ m and 20 μ m, respectively, with the buffer, sample, and waste reservoirs 2.4 mm in diameter. Separation length is 35 mm. The glass chips were purchased from Micronit Technologies, UK but several vendors, such as Microlyne, USA, manufacture comparable substrates. The prototype employs UV-VIS detection. One of the two surface-mounted light-emitting diodes (LEDs) is mounted directly above the separation channel; whereas, the other is used as a reference. Prior to sample injection, the lamp intensities are adjusted and balanced by use of a comparator. Once the separating potential is applied, the output of the comparator is monitored – as analyte elutes past the detector window, the output deviates from the null balance. Using this configuration, signal-to-noise is a function of slit width (S/N increases with decreasing slit width). Currently, we are using 100- μ m diameter slits.

Sample injection and the electrophoretic separation are achieved using two separate, but identical, power supplies. The power supplies are capable of supplying between 275 to 2000 volts. Currently, the prototype uses an AC adapter with a built-in 9-volt transformer but the design can be easily reconfigured for use with two 9-V batteries thus making the unit field-portable. Initial experiments use bromocresol green as the target analyte because the conjugate base has a large molar absorptivity coefficient in the yellow-region of the visible spectrum, which facilitates troubleshooting design modifications. Prior to sample loading, the channels were rinsed with 0.1M NaOH for 60 seconds. The running buffer was a 10 mM sodium borate solution adjusted to pH 7.5 using 0.1 M HCl. A two-step high-voltage procedure was employed to inject the sample and perform the separation. Sample injection was achieved by applying 600 V to the waste reservoir while grounding the sample, buffer, and detector reservoirs. Once sample injection was complete, a separation voltage of 1000 V was applied to the detector reservoir and the buffer reservoir was grounded. At the same time a 300 V potential was applied to both the sample and waste reservoirs to avoid leakage of analyte from the sample and waste channels into the separation channel. Based on the above operating conditions, the migration time for bromocresol green is 64.5 seconds.

The cost to manufacture a device that employs both electroanalytical and LIF detection methods is estimated at \$750.00 U.S.

Analytical Chemistry, Capillary Electrophoresis, Criminalistics

B75 Laboratory Quality and Efficiency Without Robotic Dependency

Sean E. Patterson, MS, Suzanne M. Barritt, MS, Chad M. Ernst, BS, James P. Ross, BS, and Louis N. Finelli, DO, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Building 101, Rockville, MD 20850*

After attending this presentation, attendees will have learned how to manage a high-throughput laboratory without robotics.

This presentation will impact the forensic community and/or humanity by demonstrating how to improve laboratory management and sample processing.

Elimination of errors while maintaining a high volume of throughput is a goal of any forensic laboratory, and the mitochondrial DNA (mtDNA) section of the Armed Forces DNA Identification Laboratory (AFDIL) is no exception. In order to meet increasing output demands while maintaining forensic laboratory standards, the mtDNA section has developed several novel practices and non-robotic procedures for storing, handling, and processing DNA sequencing samples.

All samples entering the AFDIL are registered in the in-house network application: Laboratory Information Systems Application

(LISA). LISA facilitates the generation of forms for all scientific procedures in a step-wise fashion. LISA has been programmed to arrange selected samples on forms in such a way as to optimize the use of reagents and machine time. The scientist processing the samples indicated must sign off each form upon completion. This creates individual responsibility for sample processing and storage. LISA also stores the electronic forms indefinitely, enabling scientists to view the processing history of a sample and reprint any forms they wish.

The mtDNA section is comprised of seven teams: six responsible for amplification and analysis and one responsible for sequencing. This compartmentalization allows for more efficient use of time and equipment as samples progress through amplification, sequencing, and analysis in assembly line fashion. With ever-increasing numbers of samples at various stages of processing, keeping track of them and maintaining order in storage freezers has become increasingly difficult. In lieu of an expensive barcode tracking system, a system of color coding and designated shelving has been developed to facilitate organization of samples.

One of the more difficult challenges to maintaining error-free output has been the transition from sequencing using individual 0.2 mL tubes to sequencing using 96-well plates. Individual tubes could be labeled, capped, and moved; therefore, it was easier to verify the extent to which each sample had been processed. Innovative steps have been taken to create a similar arrangement for the 96-well plates, involving a system of color-coding, labeling, and verifying. Ancient DNA samples are processed with different volumes of template based upon the resulting band intensities on ethidium-stained 2% agarose gels. Since it is tedious to program robots to process 96-well plates with different volume requirements in each well, manual set up of sequencing plates is the viable option. The use of multi-channel and electronic pipettes has reduced the number of sample transfers and shortened the set up time of sequencing reactions. Since implementing this system, output has more than tripled, from 430 sequencing samples in June 2005 to an average of just under 1500 samples per month in the next five months.

Another step that has been taken to insure the expeditiousness of sample processing is the switch from using labor intensive Centricon® column purifications to ExoSAPit to eliminate unincorporated dNTPs and primers from amplification reactions. This switch provided a doubling of output capabilities to an average of 2800 samples per month over the next six months.

The above practices along with a strong dedication to the mission of identifying and repatriating the remains of America's military men and women enable the AFDIL to process approximately 800 ancient remains specimens and 2000 family reference samples per year with great efficiency.

The views expressed herein are those of the authors and not necessarily those of the Armed Forces Institute of Pathology, the U.S. Army Surgeon General, nor the U.S. Department of Defense.

DNA, High-Throughput, Contamination

B76 Automated DNA Extraction From Forensics Samples Using ChargeSwitch® Technology and the New Invitrogen iPrep Instrument

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After attending this presentation, attendees will understand the method of automated DNA purification from forensics samples.

This presentation will impact the forensic community and/or humanity by demonstrating a method of simple, reliable, and robust purification of high quality DNA from forensics samples.

Isolation of DNA from a crime scene or reference sample is the starting point for many forensics identification methods, including the commonly used short tandem repeat (STR) analysis. High quality DNA is required for analysis, often from very small amounts of starting material that may have deteriorated due to environmental exposure. Furthermore, the increased use of STR analysis for identification means that forensics laboratories are receiving rapidly increasing numbers of samples for which time consuming DNA extractions must be carried out.

ChargeSwitch® Technology (CST) is a new, simple nucleic acid purification method that provides maximal DNA recovery, even when working with very small quantities of starting material. The technology is based on the concept of chemical pKa. DNA is bound to magnetic beads at low pH (pH 4) using optimized buffers, impurities are washed away, and highly pure DNA is eluted in standard Tris-EDTA at pH 8.5. ChargeSwitch® purification uses 100% aqueous-based buffers that do not introduce PCR inhibitors or hazardous chemicals such as chaotropic salts and ethanol to the purification process.

The iPrep™ purification instrument now combines the advantages of the ChargeSwitch technology with the reliability of automation. The iPrep™ instrument is a small benchtop instrument that uses pre-filled reagent cartridges and a standardized protocol to extract DNA from forensics samples. The instrument allows genomic DNA extraction of up to 12 samples, plus a positive control, in approximately 20 minutes. Tube transfers can be tracked using a barcode reader that records the position of both sample and elution tubes.

The performance of the iPrep™ purification instrument, iPrep™ ChargeSwitch Forensic kit and iPrep™ ChargeSwitch Buccal kit was evaluated for a wide range of case work samples including blood spots, saliva, buccal swab, hair and various sweat and touch samples. STR analysis was performed on the extracted DNA and the success rate compared to DNA extractions performed using a silica bead based DNA extractor, silica spin columns and organic extraction. The success rate for DNA purified using the iPrep™ purification instrument were comparable to or better than the above mentioned comparison techniques. DNA extraction was highly reproducible with a coefficient of variation (CV) of between 2% - 5% for pooled samples. The iPrep™ purification instrument was examined for evidence of cross-contamination and none was detected.

Use of the iPrep™ purification instrument, together with iPrep™ ChargeSwitch Forensic kit and iPrep™ ChargeSwitch Buccal kit, has been shown to increase the STR success rate of several types of low quantity starting material, increase standardization, and eliminates labor intensive steps of the DNA purification process.

DNA Purification, ChargeSwitch®, iPrep™

B77 An Examination of Primer Binding Site Mutations Occurring Between miniSTRs and Commercial Multiplex Kits

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After attending this presentation, attendees will learn information on the concordance between the Miniplex reduced-size primer sets and commercial STR kits as well as the sources of any non-concordance.

This presentation will impact the forensic community and/or humanity by identifying possible sources of non-concordance in DNA

profiles in a variety of population samples by sequencing the region between the Miniplex kits and standard STR kits.

The goal of this study is to utilize population studies involving miniSTRs and standard multiplex STR kits in order to identify primer binding site mutations between the different STR kits.

Miniplexes are a set of four multiplex STR loci which contain 3-6 reduced size STR amplicons per set. The primers are re-designed to be placed as close as possible to the end of the repeats to reduce amplified product size.¹ To avoid overlap between loci only one dye lane is used for each locus. The primer sets include 12 out of 13 of the Combined Index System (CODIS) core STR loci. Miniplexes 1 and 3 can be combined to create a six (6) loci kit called Big Mini. The Miniplex kits allow reduction in size of amplified products (amplicons) of up to 299 base pairs, with most amplicons ranging in size from 60-200 base pairs. The primers are tagged with fluorescent dyes (6FAM, VIC and NED) for detection. Because of the reduced size of the PCR products, the MiniSTRs provide a valuable tool in the analysis of samples where allele dropout and reduced sensitivity of larger alleles occurs due to degradation of the DNA.

Concordance studies are used to demonstrate that these new primers will produce consistent genotypes when compared to those generated by commercial kits. Concordance studies have been performed for Asian, African American, Caucasian, and Hispanic population samples. Results generally show a 98% concordance between MiniSTRs and commercial STR multiplexes with most of the differences occurring at two loci, vWA and D13S317.² To perform these studies, DNA concentrations ranging from 200 to 300 pg were amplified with Big Mini, Mini 2 and Mini 4 kits in a 25 µl reaction volume for 33 cycles. Lower amounts of template were necessary due to the increases sensitivity of the MiniSTRs. The analysis of the samples was performed using organic extractions with real time PCR for quantification. Amplification and typing were performed using the Identifiler™ and Miniplex Kits.

Primer binding site mutations can lead to allele drop out or low sensitivity of one allele during DNA analysis. Even though the presences of many polymorphisms were taken in consideration during development of the Miniplex kits, unknown problems may still emerge. Among the samples where lack of concordance was found, representative samples from different loci were chosen to be sequenced. Previously unknown polymorphisms within the primer binding sites were detected in certain samples, leading to allele loss and non-concordant homozygous profiles. Deletions between the primer binding sites for the Miniplexes and the commercial kits were another source of non-concordance, resulting in allele calls that were one repeat unit larger than those produced by the commercial kits.

Interestingly, in these studies instances where redundancy in sequence permitted primer binding in spite of the presence of deleted sequences were found. Overall, the result of this work demonstrate a high degree of concordance between the different amplicons and the sequencing data reveals the direct effect of primer binding mutations on allele calls.

¹ Butler, J.; Shen, Y.; McCord, B. *The Development of reduced size STR amplicons as tools for analysis of degraded DNA*. Journal of Forensic Sciences, 2003, 48(5), 1054-1064.

² Drábek, J.; Chung, D.; Butler, J.; McCord, B. *Concordance study between Miniplex assays and a commercial STR typing kit*, J. Forensic Sciences, 2004, 49(4), 859-860.

Miniplexes, Mutations, Concordance

B78 Developmental Validation of the AmpF/STR® MiniFiler™ PCR Amplification Kit: A 9-Plex MiniSTR Assay for the Analysis of Compromised DNA Samples

Robert E Lagace, BS, Julio Mulero, PhD, Chen-Wei Chang, PhD, Dennis Wang, PhD, and Lori Hennessy, PhD, Applied Biosystems, 850 Lincoln Centre Drive, Foster City, CA 94404*

The goal of this presentation is to share the results from the developmental validation and customer test site evaluation of a new mini STR assay, AmpF/STR® MiniFiler™ PCR Amplification Kit with compromised DNA samples.

This presentation will impact the forensic community and/or humanity by providing information on the AmpF/STR® MiniFiler™ STR kit which will be useful for genotyping degraded and/or inhibited DNA casework samples which had failed in previous standard STR kits and for special circumstances such as missing persons, and mass disaster victim identification.

Forensic DNA typing is facilitated by the employment of highly polymorphic STRs. Despite the relatively small amplicon sizes (100 - 400 bp) of previous STR kits, DNA degradation due to environmental exposure can result in a lack of sufficient intact target fragments to generate a complete genetic profile. This problem is exacerbated by large multiplex STR configurations due to the wide fragment size range of amplified PCR products. Frequently, in large multiplexes, the largest STR loci fail to amplify in degraded DNA samples due to the lack of sufficient template DNA.

In recent years, successful recovery of information from degraded DNA samples has been accomplished through reduction of the size of the STR PCR products by moving primers in as close as possible to the STR repeat region. In an effort to increase the amount of information derived from compromised DNA samples, as miniSTRs, the largest eight loci in the AmpF/STR® Identifiler® PCR Amplification Kit (D7S820, D13S317, D16S539, D21S11, D2S1338, D18S51, CSF1PO, FGA). Five of these loci (D16S539, D21S11, D2S1338, D18S51 and FGA) also represent five of the largest loci in the AmpF/STR® SGM Plus® kit have been redesigned. Size reduction of the STR amplicons ranged from 33 to 208 bp. This highly informative 9-locus multiplex, which includes the sex determining locus Amelogenin, employs a 5-dye labeling technology and non-nucleotide linkers to enable simultaneous CE separation of the DNA fragments.

MiniSTR, Degraded DNA, PCR Inhibition

B79 Validation of an Automated Liquid Handling System and Application Software for Streamlined Processing of Forensic DNA Samples Using the Tecan EVO 150 and Applied Biosystems 7500 Real Time PCR System and 3130xl Genetic Analyzer

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After attending this presentation, attendees will be briefed on the use of automated liquid handling system for generation of STR profiles from forensic DNA samples.

This presentation will impact the forensic community and/or humanity by demonstrating a way for forensic labs to automate some of their procedures to help with the DNA sample backlog and the increase in DNA sample submission

Over the last two years, forensic casework and databasing laboratories have observed increases in the numbers of samples submitted to their labs for DNA testing. This increase is due, in part, to two factors: 1) the extensive backlog of evidence samples, and the lack of funding and/or personnel currently available to process these samples, and 2) implementation of legislation which fuels development and expansion of DNA databases resulting in increased submissions of convicted offender samples. These factors require an increase in throughput, and consistent, error-free sample processing and data handling. TECAN and Applied Biosystems established a relationship to develop an automated liquid handling system with application specific software to process forensic DNA samples. The goals of this project were to 1) reduce the hands on time required to set up and process samples, 2) eliminate pipetting errors (transposition), 3) streamline transfer of sample data between instruments, 4) provide extensive validation of the system, and 5) establish a flexible system foundation that is expandable to accommodate additional applications in forensic laboratories, and that will allow further improvements in processing speed and efficiency.

This presentation summarizes the work performed to develop and validate an automated liquid handling system for DNA quantification and STR profiling using the Applied Biosystems Quantifiler® DNA Quantification Kits and AmpF/STR® PCR Amplification Kits. The hardware for the automated system consists of a Tecan Freedom EVO® 150 for liquid handling, the Applied Biosystems 7500 Real Time PCR System for DNA quantification, an Applied Biosystems GeneAmp® PCR System 9700 for STR amplification, and an Applied Biosystems 3130x Genetic Analyzer for detection of the amplified STR markers.

Pipetting methods and liquid classes were developed by Tecan automation specialists based on the specific components and requirements of each Applied Biosystems kit. All methods and classes were individually tested and validated on the Freedom EVO® 150 prior to testing in the completed system. Extensive cross contamination studies were performed to confirm the ability of the Freedom EVO® 150 to consistently assemble reactions without contamination. Testing of individual software components was performed throughout software development, and a comprehensive software system test was performed prior to validation of the entire system.

Validation of the entire automated system consisted of processing mock forensic sample DNA extracts through DNA quantitation, DNA normalization, PCR amplification, and generation of the STR profile. Results from the automated system were compared to results generated manually for genotype concordance and peak heights.

Automated Liquid Handling, AmpF/STR, DNA Quantitation

B80 The History of the Association of Forensic DNA Analysts and Administrators (AFDAA)

Joseph E. Warren, PhD, University of North Texas Health Science Center Fort Worth, Department of Pathology and Anatomy, 3500 Camp Bowie Boulevard, Fort Worth, TX 76107; Aliece M. Watts, MS, Association of Forensic DNA Analysts and Administrators, 11001 Smallwood Drive, Burleson, TX 76028; Brady Mills, BS, Texas Department of Public Safety, PO Box 4143, Austin, TX 78752; and Catherine Caballero, BS, Applied Biosystems, Inc., 850 Lincoln Centre Drive, Foster City, CA 94404*

After attending this presentation, attendees will learn of the history of the Association of Forensic DNA Analysts and Administrators (AFDAA), a “grass-roots” organization that began in Texas for Forensic DNA analysts.

This presentation will impact the forensic community and/or humanity by informing Forensic DNA analysts of the existence of an organization that encourages interaction among each other to share testing tips, new techniques, and problem troubleshooting.

The Association of Forensic DNA Analysts and Administrators (AFDAA) is a nonprofit organization composed of professionals engaged in the forensic aspects of DNA analysis for the judicial system. Members include forensic DNA analysts, supervisors, and administrators. AFDAA provides a forum for the exchange of ideas and information among forensic DNA scientists to:

- keep current on the methods, techniques, and procedures presently used in the field of forensic science
- promote the dissemination of information on research and developments of new techniques within the field
- discuss the latest legislative issues concerning DNA analysis
- network with other DNA crime laboratories and personnel
- obtain formal training and attend guest lectures
- share and troubleshoot forensic DNA data and/or issues.

This presentation will review the history of the organization from the group’s inception in 1990 as an informal meeting of several forensic DNA analysts. Today the current AFDAA membership is composed of over 200 forensic DNA professionals in over 75 agencies/companies across 25 states.

AFDAA is proud to be a large contributor to the professional growth of the forensic DNA community. Meeting held twice a year provide education of current and future technologies that is valuable to trainees in the field, as well, as the experienced veterans. The peer interaction of varied experience between researchers, government labs, private labs, administrators, vendors, and educators provides an important forum to share and learn from each other. For more information on AFDAA, visit the website at www.AFDAA.org.

AFDAA, Forensic DNA, Organization

B81 A Mango Bait: A Missing Girl, and a Murder

Chin-Chin Lim, MSc, MBA, Poh Ling Chia, BSc, Vicky Yuen San Chow, MSc, Koh Kheng Kee, BSc, Janice Kim Lian Kuah, MSc, Thiam Bon Lim, MSc, and Michael Ming Kiong Tay, PhD, Centre for Forensic Science, Health Sciences Authority, 11 Outram Road, Singapore, Singapore 169078, Singapore*

After attending this presentation, attendees will understand the value of characterizing fruit residues in stomach contents, and combining trace evidence and other forensic findings to link a suspect to a murder and reconstruct the events that occurred.

This presentation will impact the forensic community and/or humanity by demonstrating to the audience by means of a case study that fruit residues in the stomach contents of a murdered girl can be characterized in the forensic laboratory and used alongside other physical evidence to conclusively link a suspect and a location to the crime, and reveal how the victim was lured to her death.

On October 10, 2004, 8-year-old Huang Na was reported missing. She was last seen playing with Took Leng How at the food wholesale center that day. Took, a packer at the wholesale center and a former flatmate of Huang Na, was one of the persons interviewed by the police after her disappearance. He consistently denied involvement but gave contradictory accounts during police questioning. While appearing to cooperate, Took managed to quietly slip out of Singapore, escaping to Malaysia on October 21.

There were very few investigative leads except for Huang Na’s estimated time of disappearance, the denim jacket she wore on the fateful day and the fact that Took had bought some mangoes close to the time of her disappearance. One of the immediate concerns was to locate

the primary scene. The storeroom in the wholesale center where Took worked was considered a possibility. Forensic scientists searched the storeroom for trace evidence and biological material and found an abundance of denim fibers on the office table, on a roll of adhesive tape, on a pair of scissors, and a box-cutter in the storeroom. This was in agreement with the jacket Huang Na wore. A faint smear on the wall and a strand of hair were also found to contain Huang Na's DNA profile. The carpet had small bloodstains belonging to Huang Na and urine stains. The office table was examined for stains and several fluorescing prints resembling a child's fingerprints were found on the underside of the tabletop.

Meanwhile, three weeks after Huang Na's disappearance, Took was arrested and was brought back to Singapore. Took eventually led Singapore investigators to Telok Blangah Hill Park, where the girl's naked body was found wrapped in nine layers of plastic bags and stuffed into a carton sealed with strips of adhesive tape. The pathologist recovered some yellowish-brown residue in Huang Na's stomach and submitted it for examination.

Despite being recovered after 3 weeks, the stomach contents were examined and found to be mango residues. The seven strips of clear adhesive tape pasted on the carton were linked by physical fitting of cut ends to a roll of tape found in the storeroom; the free end of this roll had a fingerprint of Took. The carton in which Huang Na's body was stuffed was similar in class characteristics to known cartons found in Took's workplace. The nine plastic bags used to wrap Huang Na's body were similar in class characteristics, polarized light patterns and heat-seal marks to an unused plastic bag found in his workplace. The construction of the knots on these bags was also found to be similar to the known knots tied by Took. The sequential sealing by adhesive tape of the questioned carton, tying of knots, and the manner in which one bag was placed into another were carried out in a very systematic manner, drawing attention to the fact that Took was a packer. During the trial, Took elected not to testify on the grounds of diminished responsibility. The total weight of all the physical evidence strongly implicated Took in the murder, and indicated the storeroom as the primary scene of the crime.

Piecing the findings together, the prosecution submitted that Took coaxed Huang Na into the storeroom with mangoes. He could have sexually assaulted and then smothered Huang Na to death. He cut up her denim clothes, and wrapped her in the nine layers of plastic bags, before stuffing and sealing her in a carton and transporting the body to the deserted park. On August 26, 2005, Took was found guilty of the murder of Huang Na. The Judge was not convinced that Took was suffering from schizophrenia. Took appealed unsuccessfully; the Court of Appeal upheld his sentence on January 25, 2006.

Fruit Residues, Stomach Contents, Huang Na

B82 Fire Debris Analysis: Where Did We Come From? Where Do We Stand Today? Where Should We Go Tomorrow?

Eric Stauffer, MS, School of Criminal Sciences, University of Lausanne, Batochime, Lausanne, Vaud CH-1015, Switzerland*

After attending this presentation, attendees will learn about the history of fire debris analysis, its present state-of-the-art and limitations of fire debris analysis, and on what the future research in this field should focus. They will be able to go back to their laboratory, motivated to design and carry out the needed research in fire debris analysis. They will also have a good understanding of why some techniques, wrongly advertised as good for fire debris analysis, should be avoided.

This presentation will impact the forensic community and/or humanity by providing a better understanding of the present problematic in fire debris analysis: the interpretation of the results. This will result in the proper orientation of the future research in fire debris analysis, conducted by both practitioners and researchers. This research should fill the gaps and lead to an amelioration of the analysis of fire debris sample: a seriously needed improvement in forensic sciences.

It is not clear when the very first time a liquid accelerant was detected at a fire scene, but it appears that it was in the 1930s. In his 1938 book on scientific police, Marc Bischoff provided clear details of the fundamental principles of why ignitable liquid residues (ILR) at fire scenes can be detected. At that time, not only did the science stop at merely detecting the presence of such liquid, but also such detection was done in a presumptive manner rather than in a confirmatory one. The story of detecting lamp oil by soaking breadcrumbs in the suspicious liquid in order to taste it is not a legend.

In about 80 years, fire debris analysis has come very far and has accomplished an enormous amount of progress in the detection of ignitable liquid residues. Today, gas chromatography-mass spectrometry (GC-MS) is the analytical gold standard in the analysis of extracts from fire debris samples. Many other techniques have been proposed in the last few years, but only few, if any, could surpass GC-MS as the technique of tomorrow. As an example, gas chromatography-mass spectrometry/mass spectrometry, believed by a few as the answer to a better analysis of ILR, does not constitute an appropriate technique in this particular application. Its very high sensitivity contributes to lesser specificity and, therefore, to a decrease in the significance of the results. Accordingly, it should be completely avoided in fire debris analysis. Conversely, two-dimensional comprehensive gas chromatography-mass spectrometry (GCxGC-MS) is another emerging technique that offers a tremendous improvement in the analysis of ILR. It may not only become the gold standard of tomorrow, but it may also bring new insight into the interpretation of the results obtained with today's technology.

Presently, the interpretation of results is the weak point in the analysis of fire debris samples. While the technology has advanced tremendously since the beginning, and is the state-of-the-art level in analytical chemistry today, the interpretation of results did not undergo the same advance. This is a serious concern that should be shared by all practitioners and, more importantly, by researchers. Future research in fire debris analysis should principally focus on the interpretation of results, on the criterion necessary to identify ignitable liquids, and on the presence and identification of interfering products.

Parallel research has also occurred on extraction techniques at the laboratory and on detection techniques at the fire scene. A little progress has been made in the last few years, but nothing that will revolutionize the way sample preparation is carried out. The use of different detection techniques at the fire scene (such as the Ignitable Liquid Absorbent) is also a concern that must be addressed with scientific rigor in crime laboratories. The emergence of alternate fuels is also a new challenge that fire debris analysts must contend with.

This presentation will first present a very brief retrospective of the evolution of fire debris analysis. The attendees will be able to understand where fire debris analysis comes from and on what bases modern practice was built. Then, the current status of fire debris analysis in terms of technological advances and, more importantly, knowledge will be introduced. At this point, a review of the gaps in the present techniques will be thoroughly discussed. The assessment of the needs in the field of fire debris analysis will be given. Finally, the attendees will learn in which direction fire debris analysis should head tomorrow. This presentation should stimulate practitioners and researchers in the field to carry out the future research that is highly needed to make fire debris analysis progress to the next logical step.

Fire Investigation, Chromatography, Ignitable Liquid Residues

B83 Alternative Fuels and Their Impact on Fire Debris Analysis

Raymond J. Kuk, MS, and Michael V. Spagnola, BA, Bureau of Alcohol, Tobacco, Firearms and Explosives, Forensic Science Laboratory, Washington, Beltsville, MD 20705*

The goal of this presentation is to introduce two alternative fuels to fire debris analysts. The presentation will show analysts the features to look for when considering the presence of an alternative fuel in fire debris samples.

This presentation will impact the forensic community and/or humanity by demonstrating how, with the emergence of alternative fuels in the commercial marketplace, it is important that fire debris analysts familiarize themselves with these alternative fuels and understand their chromatographic fuels.

With the rising cost of crude oil and the resulting economic impact on consumers, there has been an outcry to reduce the country's reliance on foreign oil. In addition, environmental groups have called for fuels with reduced emissions. In order to address these issues, alternative fuels have been developed and some of them are becoming more available to the general public.

Biodiesel is typically produced by converting vegetable oils into methyl esters. Pure biodiesel (B100) can be used as a fuel in modified diesel engines. B100 can also be blended with petroleum diesel in various proportions. B20 (20% biodiesel), B5 and B2 are the most popular biodiesel blends because they can be used in diesel engines with essentially no modifications. E-85, a blend of 85% ethanol and 15% gasoline, is another alternative fuel that is gaining acceptance as a commercial fuel, especially in the Midwest and in government and corporate vehicle fleets. As with B100, this fuel can only be run in modified engines. The emergence of these alternative fuels may lead to their use by arsonists. Therefore, it is important for fire debris analysts to familiarize themselves with these alternative fuels and understand their chromatographic features as well.

Both B100 and B20 samples were analyzed as neat liquids extracted from a simple substrate, and from burned samples using the passive headspace concentration method (ASTM E 1412) with a charcoal strip. These samples were analyzed with a gas chromatograph – mass spectrometer equipped with a nonpolar column and a typical fire debris analysis temperature program with a final temperature of 300°C. The methyl ester components of biodiesel are readily apparent in the neat liquids and the extracted samples. These same components may be obscured in debris samples, but extracting ions specific to each methyl ester helps elucidate these compounds.

The E-85 fuel was evaluated at various stages of evaporation. At each stage, ethanol was still present along with the corresponding evaporated gasoline pattern. Small scale burn studies were conducted to determine if the method of extinguishment would affect the retention of the ethanol portion of the E-85 fuel. Samples of the E-85 fuel were placed on carpet samples and ignited. The modes of extinguishment included self-extinguishment, water extinguishment, and extinguishment with a CO₂ fire extinguisher. Each of these samples was extracted using the passive headspace concentration method (ASTM E 1412) with a charcoal strip and analyzed with a gas chromatograph – mass spectrometer. The ethanol portion of the fuel was present on the carpet sample that self extinguished, but the relative intensity of the ethanol to the gasoline was extremely low. The same was true for the samples that were extinguished with water. The proportion of ethanol in these samples was much lower than the ethanol in a proportionally evaporated sample of E-85 fuel. For the sample extinguished with a CO₂ fire extinguisher, a significant amount of ethanol was detected. The relative intensity of the ethanol to the gasoline in this sample was consistent with the evaporated E-85 samples.

Fire Debris, Alternative Fuels, Biodiesel

* Presenting Author

B84 Who Knew? Cigarettes and Gasoline Do Mix?

Richard E. Tontarski, Jr., MFS, and Kenneth D. Steckler, MS, Bureau of Alcohol, Tobacco, Firearms Fire Research Laboratory, 6000 Amundson Road, Beltsville, MD 20705; and Howard Marcus, BS, and John Malooly, BS, Bureau of Alcohol, Tobacco, Firearms and Explosives, Chicago Field Division, Downers Grove, IL 60515*

After attending this presentation, attendees will be able to dispel one of the common myths associated with the ignition of gasoline; to explain fire characteristics that impact the ignition of gasoline by a cigarette coal; and to illustrate the results of testing.

This presentation will impact the forensic community and/or humanity by dispelling the notion that cigarettes readily ignite gasoline. The presentation will provide more than anecdotal information about the phenomenon.

It is commonly believed that throwing a lit cigarette into a pool of gasoline will readily ignite the fuel. While often depicted on television and in movies, this is just another “fire investigation myth” that is used by suspects to explain how they “accidentally” lit a loved one or structure on fire.

The coal temperature of a lit cigarette is approximately 680 – 700 degrees Celsius. The autoignition temperature of gasoline is approximately 246 degrees Celsius, well below the cigarette temperature. Why is ignition not likely? A number of phenomena effect whether the gasoline will ignite.

There is no proven theory about all aspects of the phenomena that govern whether ignition will take place using a cigarette. Without a governing theory or law, one is attempting to prove a negative. This requires lots of experiments to begin to demonstrate whether ignition will occur.

The presentation will outline the theoretical considerations and discuss the results of over 2000 attempts to ignite gasoline with a cigarette. Experiments were conducted under different ambient temperature and humidity conditions. Attempts were made with cigarettes under draw and at rest. Targets were varied. Cigarettes were introduced into gasoline pools, next to gasoline pools, above pools and gasoline was atomized around the cigarette. Various textile substrates soaked in gasoline were also used as “wicks.”

Gasoline, Cigarettes, Ignition

B85 Transfer of Gasoline From Footwear to Flooring Materials: Can This Occur at a Fire Scene?

Yevgenia Kravtsova, BS, University of Toronto, 3359 Mississauga Road, Mississauga, ON L5L 1C6, Canada; and Dalia Bagby, MS, Centre of Forensic Sciences, 25 Grosvenor Street, Toronto, ON M7A 2G8, Canada*

After attending this presentation, attendees will understand that gasoline can be transferred from footwear to different flooring materials over several meters depending on the flooring type and initial quantity of gasoline used and that transfer is most likely to occur in situations where gross contamination of footwear has taken place.

This presentation will impact the forensic community and/or humanity by raising awareness of this possible mode of fire scene contamination and that the risk of a worst-case scenario can be avoided by refuelling suppression-related equipment away from the scene.

This presentation will explore the potential for post-fire introduction of a volatile ignitable liquid by contaminated footwear and subsequent identification of volatile ignitable liquid residues in the collected debris samples. It is sometimes alleged, in the courtroom, that

traces of gasoline or other volatile ignitable liquid detected in samples from the scene originated from the contaminated footwear of fire-service personnel during suppression efforts via “tracking” (i.e., the direct transfer of volatile ignitable liquid from the soles of contaminated shoes to the flooring substrates). Gasoline powered equipment, such as positive pressure ventilation fans and cutting tools, is sometimes used at fire scenes during suppression, salvage, and overhaul. This equipment may require refueling, raising the concern that volatile ignitable liquid could be inadvertently tracked into an area from which samples might be collected.

A series of experiments were done in which a known volume of gasoline was deposited on an item of footwear and the wearer walked across one of a series of common flooring substrates. Gasoline was selected as the volatile ignitable liquid used in the tracking experiments since it is a common fuel used in suppression-related equipment.

For the study, samples of pre-burned substrate were positioned along a walking path for the subject to tread upon. Tracking courses of up to 8 m were used, depending on the volume of gasoline applied. For different tracking runs, the courses consisted of either a non-absorbent substrate (linoleum tile) or an absorbent substrate (carpet or bare wood). Each of the substrates was pre-burned on the upper surface by exposure to flame from a propane torch. Another series of carpet samples were charred by exposure to the radiant heat of burning furniture in a fire cell. For each trial, a volume of gasoline (either 1 drop, 1 mL, or approximately 10 mL) was applied to the bottom of rubber-soled work-boots and tracked through the course of flooring material. For the large volume trial, done to simulate gross contamination, approximately 10 mL of gasoline was deposited on the footwear by having the subject stand in a basin of liquid gasoline and measuring the volume applied by difference. Each tracking run was followed by collection of samples at the corresponding transfer locations and each run was done at least twice. Sample collection was done as quickly as possible after each tracking run. A sample at the first step (i.e., the point of contact between the sole of the boot and the flooring) was collected and packaged within the first minute after exposure and all other samples were collected and packaged within 10 minutes. The collected samples were packaged in glass Mason jars and subsequently analyzed in the laboratory by dynamic headspace gas chromatography-mass spectrometry (GC-MS).

When 1 drop of gasoline was used, no gasoline was identified on any of the wood or carpet samples. On linoleum, no gasoline was identified beyond the first step. When 1 mL of gasoline was used, deposition was detected on all flooring types within 1m of the starting point. No deposition was observed more than 4 m from the starting point on any flooring type. When 10 mL of gasoline was used, it was possible to detect gasoline deposition no farther than 6 m from the starting point on either carpet or bare wood flooring and gasoline was identified in one of two linoleum samples taken at 8 m. Note that the contamination of footwear with 10 mL of gasoline represents, in the opinion of the authors, a degree of contamination beyond that which would be expected to occur during the refueling of equipment.

This study suggests that gasoline can be carried for a number of meters on footwear and that the distance it may be transferred is dependent upon the initial volume of gasoline deposited and the nature of the flooring material. It is incumbent on all persons present at a potential crime scene to mitigate this risk of scene contamination by avoiding the refueling of equipment in the immediate vicinity of the fire scene.

Contamination, Fire Debris Analysis, Ignitable Liquids

B86 The Body as a Fuel Load in Fatal Fire Scenes

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After attending this presentation, attendees will understand that the body should be considered a fuel load that contributes to the burning process for structural and vehicular fires.

This presentation will impact the forensic community and/or humanity by improving fire death investigation by understanding how the body contributes to fire dynamics.

In a sense, every person brings something to his or her own death that affects the process of postmortem tissue break down, fire being no exception. Independent of the burning environment (car, structural, or other) the body consists of different combustible materials that burn at different times and rates. At the most basic level, heat penetrates through layers of skin and exposes layers of fat rendering into grease. Just as each fire scene is unique, burn patterns on the body also provide important information about the fire’s progress and interaction with the victim. Inherent variables of individual fire scenes such as the spatial relationship to wicking materials; be it clothing, furniture, flooring, and other combustibles can affect how the body’s fat contributes to the burning process.

Three human cadavers were burned in structural and vehicular fires to observe the body’s contribution as a fuel load. Times and temperatures were correlated with the concurrent destruction of the body and surrounding materials. This study utilized instrumentation and software available from the Yokogawa Electric Corporation - Darwin DAQ 32 Plus collecting data from a DA100 unit remotely cabled to a DS400 unit equipped with the DV100-21 thermocouple relay. Type K thermocouples (from Omega Scientific) were connected between the DS400 and the points of temperature measurement. The unit and thermocouples were checked for continuity and reliability with the use of ambient temperatures and flame.

For this experiment, approximately 1000 mL aliquot of gasoline was poured across the chest area to initiate combustion. The gasoline provided the initial accelerant, but once consumed, heated body fat rendered into grease and acted as a fuel source and as an accelerant with burn rates close to results predicted by DeHaan and Nurbakhsh (2001). Following the first three minutes, the fire began to normalize and moderate to slower consumption of the cotton clothing progressively burning toward the cadaver’s lower extremities. Heat turned deeper layers of the body’s fat to grease and the cadaver was burning as a self-sustaining fuel source. The liquefied fat began to pool on the carpet beneath the cadaver and burned in a self-sustained combustion in a “wicking” fashion. For the entire four hours of observed burning, temperatures varied as the fire traveled from the upper body to the middle and lower with peaks between 500°C and 780°C (Figures 7-15).

In a fire, as one area of the body burns it heats the next, creating a new fuel source of liquefied fat. This grease can leach into absorbent clothing, carpeting, wood flooring, and charred muscle. For the human body, the wick effect occurs, but not directly burning on top of the body like a candle as the term implies, but instead occurs around and below the body wherever the grease pools. It should be noted that body fat needs to be absorbed or “wicked” into a natural, synthetic, cellulose, charred materials, or charred tissues to effectively burn in addition to heat and oxygen. The test was concluded after four hours of burning and could have continued longer as there were fires still burning in sections of the body. The cadaver, that had originally weighed 81.6 kg (180 lbs), had been reduced to 21.1 kg (46.5 lbs). This indicates a mass loss of 60.5 kg (133.5 lbs). The calculated mass loss rate was 15.3 kg/hr or 33.8 lbs/hr and is close to the expected rate discussed by DeHaan and Nurbakhsh (2001).

Two vehicles obtained by the Washington County Sheriff's Office were used to simulate car fires with a victim in the driver's seat. Unique environmental variables produce differential burning effects to the body. Car fires are fast, hot contained spaces capable of burning at temperatures of 1100-1600° Fahrenheit for 45 minutes to an hour. There was a concurrent process of destruction to the vehicle and fire, with the body contributing as a fuel load, increasing the burn time and destruction. The fire became fully involved before significant changes were visible to the body. Both body and vehicle were differentially destroyed by the fire's progress; but maintained their basic structural integrities for later forensic analysis.

Tissues experienced extensive destruction from heat convection and ample oxygenation as remains of the bulkier torso were suspended upon the wire support frame after all upholstery had burned away. The car fire naturally extinguished an hour after complete combustion of manufactured synthetic materials. Following this, tissues of the body continued to burn on their own for an additional hour and a half concentrated primarily around the torso and from liquefied body fats, creating the wick effect and producing additional sources of fuel.

Throughout these experiments, body fat melted and pooled around the body and became a fuel source for the fire, burning upwards and causing additional body fat to render into more grease. A person's weight and body-fat contributes to the burning process. DeHaan and Nurbakhsh (2001) investigated the effects of body fat during combustion experiments using pig models. While the anatomy may differ, the properties of fat melting into grease and burning as a fuel source remain valid.

Fire Fatalities, Fire Investigation, Cremation

B87 A Study of the Trace Evidence Aspects of Partially Burned Gunpowder Particles and the Adaptation of SWG-MAT Trace Evidence Recovery Guidelines for the Analysis of Gunpowder Residues on Clothing

Richard N. Ernest, BS, Alliance Forensics Laboratory, Inc., 6058 East Lancaster Avenue, Fort Worth, TX 76112*

After attending this presentation, attendees will better understand how to use trace evidence recovery techniques for extracting gunpowder residues from clothing, and will have a better understanding of the various morphological & flight characteristics of partially burned gunpowder particles and particle fragments. Case examples will be given.

This presentation will impact the forensic community and/or humanity by providing a better understanding of the use of trace evidence recovery techniques for extracting gunpowder residues from clothing, and will have a better understanding of the various morphological & flight characteristics of partially burned gunpowder particles and particle fragments. This will lead to more accurate determinations of distance involving casework.

Objectives: Current methods for the analysis of gunshot residue particles on clothing rely on visual examination followed by chemical testing. In this paper, the use of SWG-MAT trace evidence recovery guidelines, as an adjunct test to current methods, to further recover essentially all gunshot residue particles embedded from all surfaces of the clothing will be outlined. This information can be critical in certain types of shooting cases (to be discussed) to answer issues of the distance involved in the shooting. Several case studies from prior casework employing these techniques will be discussed.

Methodology: After the use of current visual examination techniques and chemical testing for gunshot residues is concluded, the clothing items are examined using a variety of trace evidence techniques

such as tape lifts, scraping techniques and vacuuming techniques. The resultant debris isolated from the clothing may contain numerous microscopic particles of gunshot residue which can be examined by various methods which will be discussed. Various common forms of trace evidence debris normally isolated from gunshot residues will be outlined, and the ranges to which some of this debris may be encountered following the discharge of a firearm will be discussed.

Results: Trace evidence analysis of the gunshot residue debris encountered from the firing of a firearm may allow in certain cases for a further characterization & determination of the range(s) at which a firearm was fired. In certain types of shooting case scenarios, such information can be crucial to the solving of the case.

Conclusions: Trace evidence analysis of the gunshot residue debris encountered from the firing of a firearm is not a technique which should be used in every type of shooting case, but it is a technique which can be used in certain types (to be discussed) which can lead to valuable or critical information which may be useful to the solving of a case.

Gunpowder, GSR, Trace Evidence

B88 Analysis of Post-Blast Residues of Black Powder Substitutes by Ion Chromatography and Capillary Electrophoresis

Megan N. Bottegal, BS, and Bruce R. McCord, PhD, Florida International University, 11200 SW 8th Street, Miami, FL 33199; and Leslie Adams, BA, Miami-Dade Bomb Squad, 400 NW 2nd Ave, Miami, FL 33128*

After attending this presentation, attendees will have been introduced to new developments in the analysis and detection of black powder substitutes.

This presentation will impact the forensic community and/or humanity by demonstrating methods to identify both the fuel and oxidizer molecules in the event that a black powder substitute is used in the construction of an improvised explosive device; this information can provide an investigative lead for law enforcement personnel.

Given that black powder substitutes are legal to purchase and possess in significant quantities, their use in improvised explosive devices (IEDs) has become a concern both locally and globally. It is important to be able to identify both the fuel source and the oxidizer during the analysis of post-blast residue in order to identify the original explosive material. This information can provide an investigative lead for law enforcement personnel in the event of an IED blast.

Black powder substitutes are alternative propellants that are formulated to generate less smoke and cause less corrosion to the gun barrel than traditional black powder. These formulations generally contain inorganic oxidizers such as KNO₃ and/or KClO₄. While charcoal has been the traditional fuel source in these powders, in recent years, several manufacturers have instead turned to ascorbic acid (vitamin C). This compound has the advantages of water solubility and a reduced smoke output when burned. These characteristics of ascorbic acid result in less fouling of the gun barrel, leading to a faster reloading time.

Little is known about the types of residues formed when these new black powder substitutes are used as the explosive filler in pipe bombs. It is important to determine whether the products of open burning of these propellants are different from those resulting from the heat and pressure of an explosion. Powders from different manufacturers may give different products when deflagrated; this information can be used to identify one powder from another. The identity of these products, and reproducibility of their formation, will be determined.

A series of pipe bombs were constructed and deflagrated under controlled conditions to determine what factors influence post-blast residue formation. Seven different types of black powder substitutes were evaluated to determine what residues they commonly produced when confined and detonated as a pipe bomb. These residues were then compared to those formed in open burning and present in unburned powder. Quantification of levels of anions present allowed for the determination of the percent composition of each powder. This approach allowed for discrimination between different powders. Factors to consider included the temperature of the explosion, the packing density of the powder, brand, and lot of powder, and type of containment material used. The powders used in this study included four ascorbic acid based powders, two charcoal based powders, and traditional black powder. To prevent contamination and contain the pipe fragments, each shot was contained within a plastic bucket. Initiation occurred via an electric match to minimize safety hazards.

Analysis of pre-burn, post-burn, and post-blast residue was carried out using ion chromatography (IC) and capillary electrophoresis (CE). Target analytes included perchlorate, chlorate, nitrate, nitrite, and ascorbic acid. Concurrent use of these two complementary separation techniques allowed for presumptive identification of the compounds of interest.

Explosives, Ion Chromatography, Capillary Electrophoresis

B89 Practical Applications of Pattern Recognition to the Post-Blast Analysis of Black Electrical Tape

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After attending this presentation, attendees will understand the utility of using the statistical models Agglomerative Hierarchical Clustering (AHC), Principal Components Analysis (PCA), and Discriminant Analysis (DA) in identifying and comparing black electrical tape samples in a post-blast environment.

This presentation will impact the forensic community and/or humanity by demonstrating how statistical models can correctly assign samples of black electrical tape with their nominal brand in a post blast scenario.

Black electrical tape is commonly found at crime scenes and the brand identification and/or association of a sample back to its roll of origin can be paramount to the course of an investigation. In this study, the ability of multivariate statistical techniques to correctly identify and compare intact and post-blast tape samples was evaluated. An exemplar brand of black electrical tape was wrapped in multiple layers on the outside of three pipe bombs, and a second brand was located inside the devices, wrapped around plastic bags containing the propellant Pyrodex. Two of the bombs were initiated with electric matches, one of which was fumed with cyanoacrylate in the field. A third device was used as a control.

In the debris field, multiple pieces of electrical tape were found either on the pipes or nearby and ranged in size from fairly intact multi-layered tape fragments to small shards of extremely damaged single-layer tape. Most tape found consisted of at least two layers which, upon separation, allowed for testing of a relatively clean adhesive or backing surface. As a result, all collected fragments were amenable to chemical analysis with the exception of one badly damaged tape shard. The smallest of the useable fragments had an area of approximately one square centimeter. The backing portion of the tape fragments was cleaned using a clean cotton swab, while the adhesive side was picked as clean as possible using forceps. The backing portion was analyzed

with Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM-EDS) and Fourier Transform Infrared Spectroscopy (FTIR), while the adhesive layer was analyzed only with FTIR. The elements identified via EDS in the tape backing were expressed as net peak areas. All elements that were present at or above the limit of quantitation of the instrument were normalized by summing the square of all peak areas for that sample and dividing each peak area by the square root of that sum. The FTIR data was also normalized using the sum of squares approach. The results were then evaluated using multivariate statistical models.

Using the averaged normalized data for both techniques, AHC was performed. This technique groups the data by its similarity/dissimilarity, placing similar samples in a single group while excluding others. An AHC dendrogram results, which shows families of tapes grouped together. PCA analysis further discriminates samples by expressing the variations in multi-dimensional data as principal components, the first few of which account for the majority of the data variation and can be plotted visually in two or three dimensions. Further analysis of the PCA data was done using DA, which utilizes a learning set of tape exemplars to optimize the grouping of the samples. DA can then assign unknown samples to a known brand of electrical tape, thus allowing for the identification of post-blast material.

An extensive collection of tape exemplars was used in this study, comprising over 80 rolls of 0.75 inch nominal width black electrical tape that represented over 30 nominal brands, 8 manufacturers, and 3 countries of origin. To allow for better discrimination, rolls were divided into two categories based on the color of their adhesive. Tapes with black adhesive were successfully differentiated by brand 89% of the time using SEM-EDS and subsequent evaluation by DA, with two brands having largely indistinguishable surface textures and elemental compositions. AHC analysis of FTIR data, on the other hand, was able to elucidate a difference between these two brands. The clear adhesive tapes were divided into those that do or do not contain aluminosilicate filler. For tapes that do not contain aluminosilicate filler, DA assigned the known rolls to the correct brand 98% of the time. For tapes that do contain aluminosilicate, DA assigned the correct brand 99% of the time. For the post-blast material, the two known tapes utilized were clear adhesive, non-aluminosilicate filler tapes. After detonation, seven samples ranging from one to five layers of tape were recovered. Based on SEM-EDS and FTIR analysis combined with multivariate statistical models, two of the multi-layer tape fragments were correctly assigned to tape brand applied to the exterior of the devices. The remaining five tape fragments were correctly assigned to the tape brand applied to the interior of the devices.

General statement of conclusion: Using multivariate statistical models, fragments of electrical tape found in a post-blast debris field were identified to their nominal brand.

Electrical Tape, Multivariate Statistics, Explosives

B90 New Approach for the Analysis of Duct Tape Backings

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After attending this presentation, attendees will be aware of the various multi-layered duct tape backings that can be encountered and how the FBI's standard operating procedure for duct tape analysis has been modified to account for these multi-layered backings.

This presentation will impact the forensic community and/or humanity by providing information that affects the forensic analysis of duct tapes.

Duct tapes are often submitted to crime laboratories as evidence associated with abductions and homicides. Within the FBI Laboratory,

duct tape is analyzed for comparative examinations or for sourcing purposes. The objective of the tape comparison examination is to determine the possibility of an evidentiary link between a suspect and a crime or between different crime scenes. When there is no source available for comparison, a duct tape specimen can be examined to determine class characteristics that may provide manufacturer information.

A logical first step for either comparative examinations or sourcing requests is to conduct visual and microscopic examinations on the submitted samples in order to evaluate physical characteristics such as backing color, adhesive color, width, yarn count per square inch, and weave pattern. If the samples are consistent following visual and microscopic examinations, chemical composition analysis is performed on the three main components of each tape: backing, adhesive, and reinforcement fabric.

Prior to this study, duct tape backings at the FBI Laboratory were inspected visually and microscopically for color and fabrication markings, measured for width and thickness, and analyzed by scanning electron microscopy / energy dispersive X-Ray spectroscopy (SEM/EDS) for elemental content and by X-Ray diffraction for crystalline compound information. No additional examinations were typically performed on the backings, because the expectation was that little discrimination would be offered.

However, while conducting casework examinations on a duct tape specimen, it was determined that the backing was multi-layered. Following additional analysis and discussion with industry contacts, the use of multi-layered backings was found to be a common tape-manufacturing practice. Therefore, the FBI Laboratory initiated a study to determine how frequently multi-layered backings might be encountered, what types exist, and how they should be properly examined.

This study involved the analysis of eighty-two duct tape samples that have been acquired by the FBI since 1993. Most of the tapes were purchased at discount stores or home-improvement retailers, are marketed as general purpose or economy grade, and cover a variety of U.S. and foreign manufacturers. Therefore, the group represents tapes that could be easily obtained by consumers and would be comparable to casework evidence submitted to the FBI Laboratory.

A variety of different backing layer structures was observed through the use of visual and microscopic examinations as well as Fourier transform infrared spectroscopy with an attenuated total reflectance attachment.

As a result of this study, the FBI Laboratory's standard operating procedure for tape analysis has been modified. Microscopic examinations are now performed on duct tape backing cross-sections to identify any possible layers. Furthermore, the protocol has been modified to include FTIR-ATR analysis of both sides of the backings. Following these analyses, the results obtained may lead to discrimination between two samples that may not have been differentiated otherwise. Even when no differences are found following these examinations, the layer structure may influence the sample preparation for subsequent analyses (e.g., SEM/EDS).

Duct Tape, Microscopy, Attenuated Total Reflectance (ATR)

B91 Comprehensive Fiber Analysis and Classification

Donna M. Radice, Joshua A. Gunn, BfSc, and Suzanne C. Bell, PhD, West Virginia University, Eugene Bennett Department of Chemistry, 217 Clark Hall, Morgantown, WV 26506*

The goal of this presentation is to introduce polarized light microscopy, along with, IR, and Raman spectroscopy as methods to characterize and quantify weathering effects of fabrics and fibers.

With a database of chemical composition characteristics compiled from research with PLM, FTIR, and Raman, fibers could be more readily differentiated and characterized according to age and weather. This presentation will impact the forensic community and/or humanity by giving the forensic community an opportunity to utilize fiber evidence more so than in the past. Since fibers are prevalent among crime scenes, this new database would give new insight into a fiber's origin. With more research, fibers could be chemically characterized where two identical fibers could be differentiated. With more research, fibers would have more evidentiary value and would finally be pivotal evidence in forensic cases.

Novel methods for analyzing the chemical characteristics of fibers must meet certain criteria in order to be acceptable in the forensic laboratories. Methodologies must employ readily available instrumentation, be rapid and non-destructive, and require minimal sample preparation. With those goals in mind, primary methods for identification being researched are bright-field/polarized light microscopy, FTIR microscopy, and Raman spectroscopy.

Many studies have been done on the chemical characterization of fibers, but few have gone beyond the realm of chemical differences in manufacturing. Very few studies have conducted any testing on fibers that have been aged or have looked at the differences in chemical composition over time. It is the goal of this work to:

1. Determine which chemical characteristics of fibers are attributed to manufacture.
2. Determine which chemical characteristics are attributed to weather.
3. Determine if chemical characteristics caused by weather can be useful in discriminating between otherwise identical fibers.

Fibers in this study were analyzed using a combination of PLM, FTIR, and Raman microspectroscopy over a time period during which they were subjected to simulated weathering conditions and the chemical changes were tracked. Four types of fibers were tested; cotton, nylon, polyester, and rayon. These fibers were dyed four different sets of colors in three different shades. Each fiber has a light, medium, and dark swatch of red, yellow, blue, and green, as well as unprocessed uncolored fibers. For the PLM experiments, fibers were cut into inch by inch squares and arranged in plastic pallets with small holes to access the fibers. One pallet was exposed to UV light and the other was washed repeatedly. For the PLM, LAB coordinates were taken to track the color changes over time as the fibers were artificially weathered. Using chemometrics, color degradation could be graphed over time for both pallets. For the FTIR, fiber swatches approximately inch by inch were taped to the shiny side of aluminum foil wrapped around glass slides. IR spectra were taken of each make and color of fiber before and after successive UV exposures. For the Raman, fiber swatches were again taped to the shiny side of aluminum and spectra were taken before and after successive UV exposures.

This comprehensive study has proven successful in identifying discernible chemical changes occurring over time due to the simulated weathering of fibers through UV exposure and washing. Chemometric analyses have shown a decrease in color as the fibers have been aged through PLM. IR spectra show noticeable differences between exposures. It is the hope of this work that the data would be organized into a database where a questionable fiber's chemical characteristics could be plotted and compared to standards. Chemical characteristics could indicate the age or degree of weathering, such as to discern between a brand new and an older fiber.

IR, Raman, Fibers

B92 Does the Recovery Method Affect the Quality of Test-Fired Bullets?

Ryan J. Postlethwait, BS, Forensic Science Initiative, 3040 University Avenue, Suite 3102, Morgantown, WV 26505-6217*

After attending this presentation, attendees will learn the different physical alterations that are experienced by hollow point ammunition when fired into a water tank and a cotton box.

This presentation will impact the forensic community and/or humanity by providing information that will be useful for agencies that employ a water tank or a cotton box to retain test-fire ammunition. These bullet recovery systems have damaging effects on test-fired bullets, which will be discussed in order to understand how it may compromise the examination process.

The goal of this presentation is to study the physical alterations of hollow point ammunition when fired into a water tank and a cotton box.

The purpose of this study is to observe how the physical properties of a hollow point bullet are affected when using different ammunition collection devices. The two common devices that are used are the water tank and the cotton box. The test-fired bullets are subsequently collected and compared to any bullets recovered from the crime scene in order to determine if they can be associated to the firearm collected at the crime scene. The test-fired bullets can also be compared to bullets collected from previous crime scenes in order to possibly link the recovered firearm to prior crimes.

The bullet will experience land impressions when it travels down the barrel of the gun. The individual characteristics that are transferred onto ammunition after being fired allow for that bullet or cartridge case to be linked back to the particular firearm from which it was discharged. These marks are different for each firearm and are caused by the rifling of the gun barrel, a manufacturing process that allows the fired projectile to gain accuracy and gyroscopic stability. The quality of the markings on the test-fired ammunition is critical to its examination with a comparison microscope or the Integrated Ballistics Identification System (IBIS).

The water tank and cotton box both create problems when they are employed as a collection device for hollow point ammunition. The water tank causes a mushroom effect to the tip of the bullet. This distorts the physical shape of the bullet, making examination of the land impressions more difficult. Unlike the water tank, the cotton box can ensure that the physical shape of the recovered bullet is intact. However, the cotton fibers can be abrasive to the outside of a fired bullet, causing unwanted striation marks, and distorting the marks and impressions caused by the firearm.

This study compares the effects that each ammunition collection device has on the same type of ammunition. The comparison microscope and IBIS are used to evaluate the bullets qualitatively and quantitatively.

Bullet Recovery, Firearms, IBIS

B93 Comparing the Performance of IBIS and Bullet TRAX-3D™ Technology Using Bullets From Ten Consecutively Rifled Barrels

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After attending this presentation, attendees will understand the basic principles of the operation of IBIS and BulletTRAX-3D™ and their ability to match fired bullet pairs.

This presentation will impact the forensic community and/or humanity through the new 3D technology of BulletTRAX-3D™ which has the ability to link many more crimes involving firearms.

The majority of papers published on the Integrated Ballistics Identification System (IBIS) to date have focused on its ability to link cartridge cases. Few studies have been done to examine the performance of IBIS with bullets. Those that have been undertaken, suggest that IBIS is less effective when it comes to its ability to link bullets fired by the same weapon. It is proposed that the new technology of BulletTRAX-3D™ will result in better characterization of the bullet's surface and this in turn will translate into improved results over those observed to date with IBIS.

Ten consecutively rifled Para-Ordnance P10-45 handgun barrels were test fired to obtain reference sample and known match sample pairs for upload onto the IBIS and BulletTRAX-3D™ bullet acquisition systems. Forty bullets were uploaded in total, twenty copper-jacketed bullets, and twenty lead bullets, to account for the variations in the manner in which markings are reproduced on bullets of different metal compositions. The bullets were uploaded into a database, which contained 476 entries of the same caliber and rifling characteristics (.45 calibre bullets with six lands and grooves with a left-hand twist). Ranked correlation lists were examined to determine if the two systems could link reference samples to their known match and where in the list that identification was made (within the top 10, within the top 20, or outside the top 20 positions). It is important to examine where in the list matches appear as an operator may miss potential hits if they appear too far down the list.

For copper bullet correlations, both IBIS and BulletTRAX-3D™ identified all reference samples to their known matches within the top 10 positions. BulletTRAX-3D™ performed significantly better with lead bullets and inter-composition comparisons. For lead bullets, BulletTRAX-3D™ identified all reference samples to their known match in the top 10 positions. IBIS on the other hand, identified only 30% of reference samples to their known match in the top 10 positions and 70% outside of the top 20 positions. For copper to lead comparisons, IBIS identified 20% of reference samples to their known match in the top 10 and 80% outside of the top 20. BulletTRAX-3D™ identified 90% of the reference samples to their known match in the top 10 positions and 10% in the top 20. IBIS fared slightly better with lead to copper comparisons than it did with copper to lead comparisons. For lead to copper comparisons, IBIS located 20% of matches in the top 10, 60% in the top 20, and 20% outside the top 20. BulletTRAX-3D™ was again superior as it identified 90% of matches in the top 10 positions and 10% outside the top 20.

BulletTRAX-3D™ was found to perform better than IBIS in the comparison of lead bullets and inter-composition comparisons. BulletTRAX-3D™ also produced images of superior quality and includes a graphical representation of each image that is not available with IBIS. This provides further visual support to aid in the identification of potential hits.

IBIS, BulletTRAX-3D™, Fired Bullets

B94 Micro-Marked Firing Pins: Character Durability and Impression Legibility

David Howitt, PhD, Frederick Tulleners, MA, and Michael Beddow, MA, University of California, 1 Shields Avenue, Forensic Science, Davis, CA 95616*

After attending this presentation, attendees will be briefed on information about the concept of firearm labeling.

This presentation will impact the forensic community and/or humanity by improving the understanding of the laser identification methods.

The placing of micro-marks on specific firearm components, that would in turn be transferred directly to the ammunition upon discharge, has been proposed to assist in the identification of expended ammunition components found at crime scenes. Versions of this technology involving the laser engraving of firing pins have been developed by companies such as Pivotal Development and Laser Automation Gekatronik. The technology initially involved masking but has subsequently developed into a direct laser writing method where a pattern of characters is cut into the firing pin by locally ablating the metal surface. The scale of these characters is small enough that a unique identification of the firearm can be embedded on the firing pin that is invisible to the naked eye but decipherable at a magnification of about 25 times. The obvious concerns with this type of labeling are the visibility and persistence of the impression evidence that is produced and the ease with which micro-characters can be removed by the user. When a firearm is discharged the firing pin moves forward to strike the primer that is composed of a thin metal cup, typically made of brass, which contains a contact sensitive chemical mixture. The impression of the characters into the primer is the result of both the velocity of the firing pin and the pressure created by the deflagration of the gunpowder. As long as the markings extend beyond the length of the firing pin that can potentially impact the primer, deliberate attempts to completely remove the characters should also defeat the operation of the firearm.

In response to the development of this technology the State of California proposed an amendment to Sections 12126 and 12130 of the California Penal Code in the form of Assembly Bill 352 (AB 352) in February 2005. This bill required that "Commencing January 1, 2009, all semiautomatic pistols that are not already listed on the "not unsafe handgun" roster shall be designed and equipped with a microscopic array of characters that identify the make, model, and serial number of the pistol, etched into the interior surface or internal working parts of the pistol, and which are transferred by imprinting on each cartridge case when the firearm is fired."

In light of this legislation a research project was initiated to investigate the viability of this technology by engraving micro-serial numbers and radial bar coding on the faces of firing pins and testing the durability and longevity of the impressions that they produce. The testing of this technology was carried out with multiple brands of ammunition on a variety of different caliber semi-automatic handguns, two semi-automatic rifles and a pump shotgun. This testing was conducted, in part, with the assistance of the California Highway Patrol (CHP) Academy. Six engraved firing pins were placed on the Smith and Wesson Model 4006 firearms used by academy recruits. All of the firing pins and cartridge cases have been evaluated microscopically to determine the consequences to the impressed characters. The results of these findings will be presented.

Firearms, Code, Identification

B95 Application of Laser Microdissection to Expedite Forensic Sexual Assault Casework

Kelli B. Raley, MSFS, North Louisiana Criminalistics Laboratory, 1115 Brooks Street, Shreveport, LA 71101*

After attending this presentation, attendees will learn that laser microdissection may be an alternative method to traditional sexual assault sample analysis.

Since DNA evidence has proven itself to be a powerful tool in the courtroom and CODIS has shown that recidivism is a serious threat to the public, demands from local communities for time-sensitive testing in forensic DNA laboratories has become commonplace. Therefore, a good forensic DNA section must reexamine traditional testing procedures to make efficiency a primary goal. This presentation will impact the forensic community and/or humanity by giving the audience an alternative tool that has the potential to improve on, and make more efficient, traditional sexual assault sample analysis.

Whenever possible, a good forensic DNA section must reexamine traditional testing procedures to make efficiency a primary goal. In order to reorganize the DNA section's analysis of samples, the North Louisiana Criminalistics Laboratory (NLCL) identified bottleneck areas in the DNA analysis procedure. Because at least 45% of all DNA cases at the NLCL involve sex crimes, one clear hindrance is the differential extraction of sexual assault samples. Examination of sexual assault evidence (i.e., locating, identifying, and the differentially separating sperm from epithelial cells) results in an extraction process that is time consuming and often imperfect. Laser microdissection (LMD) may be used as an alternative to this process to expedite and improve the separation of sperm and epithelial DNA.

The NLCL chose to validate the Leica™ AS LMD Microsystem to help process sexual assault samples. By using the LMD microsystem, the analyst has the potential to concurrently identify, separate, and quantify sperm and epithelial cells in about an hour. As a result, examination to data analysis can be shortened to less than two days. The overall savings in time will result in decreased sexual assault casework turnaround. Also, LMD analysis will free up analysts' time, allowing much needed time for analysis of other casework, QA/QC, research, and especially keeping up with paperwork and maintenance duties that come with finalizing cases. Overall, successful validation of LMD should help fulfill the demand for time-sensitivity needed in DNA casework at the NLCL.

Principal research for DNA typing from sperm cut via LMD has included: (1) physical separation and counting of sperm and epithelial cells from polyethylene (PEN) slides, (2) use of techniques for pre-amplification sperm lysis, (3) investigation of both reduced volume PCR amplification (RVPCR) and PCR with increased cycle numbers to increase sensitivity, (4) excision of sample spot from the PEN slide for STR analysis in the absence of sperm, and (5) troubleshooting of DNA results. The simultaneous identification and quantification of sperm, and their separation from epithelial cells via the LMD microsystem has been successful. Focus has shifted to sperm cell analysis or detection of male DNA post-LMD, all the while maintaining reduced analysis times.

Pre-amplification treatment of sperm collected via LMD with Proteinase K and DTT, coupled with RVPCR, has provided the best DNA typing results. In the absence of sperm, the sample spot has been successfully excised from the PEN slide and analyzed by traditional methods, showing comparable yield. Since increased sensitivity is desired in order to dissect as few cells as possible, low copy number (LCN) interpretation has to be considered in DNA typing results. Additionally, yield has been shown to be affected by static charge produced by the laser. DNA electropherograms recently have exhibited higher than baseline peaks, showing a need to address possible contamination issues that may come into play with the LMD microsystem in LCN samples.

Laser Microdissection (LMD), Differential, Reduced Volume PCR (RVPCR)

B96 Novel Techniques for Identifying the Semen Donor in Extended Interval Post-Coital Samples

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The goal of this presentation is to aid caseworkers in understanding how to best recover the male profile of a post-coital sample, thus allowing attendees to develop semen donor DNA profiles from samples recovered >72 hours after intercourse.

This presentation will impact the forensic community and/or humanity by informing the forensic science community of various novel strategies to recover DNA profiles from extended interval post-coital samples using Y-STR technology. Moreover, detecting a Y-STR male profile with samples collected greater than 72 hours after intercourse is of value to forensic casework because in most instances it is unlikely that an autosomal STR profile of the semen donor would be obtainable with vaginal samples taken then.

In forensic casework some victims of sexual assault wait to provide vaginal samples more than 36 hours after the incident. In these cases the ability to obtain sperm diminishes as the post-coital interval is extended. Absence of significant numbers of spermatozoa in such specimens can be due to the victim's behavior after the assault (showering, douching, using spermicidal agents, and vaginal vault drainage), menstruation, and vaginal inflammation. Previous data demonstrated that it is possible to obtain Y-STR profiles from post-coital samples recovered up to 72 hours after intercourse regardless of external ejaculation or microscopic detection of sperm. In this work, the post-coital range of time points sampled was extended to include 72 hours through 168 hours and typed the extracted DNA using the both the Applied Biosystems AmpF/STR® Yfiler™ PCR Amplification Kit and Promega PowerPlex® – Y System.

Results indicated that complete Y-STR profiles were unable to be obtained after 72 hours post-coitus using a standard organic extraction technique without differential lysis and the input of 300 ng of total DNA. However complete Y-STR profiles were obtained at 96 and 120 hours post-coitus using a differential extraction method. To further extend the post-coital interval, several additional strategies were employed. Post amplification clean up was introduced which not only increases the peak height of observed alleles but permits the detection of alleles that were initially below the levels of detection. Indeed the use of post-amplification clean up produced full profiles where previously partial profiles were observed. Another strategy employed was to use enzyme cocktails incorporating proof reading enzymes to determine whether a further increase in detection sensitivity was possible.

A direct lysis of the swab contents was employed as an alternate method for post-coital analysis. Previous research in this laboratory has found that the direct lysis method is faster than standard methods and can produce reliable genotypes in samples recovered up to 96 hours after intercourse. Therefore, two modifications were made to the procedure to further extend the post-coital interval from which a semen donor profile could be obtained. The first was to clean up the extract before amplification and the second was to clean the direct lysis product after amplification. These clean up strategies remove contaminants that can interfere with downstream reactions, which in turn increases analytical sensitivity.

Post-coital samples in which one or more of these strategies have been employed dramatically improved the profile quality and increased the post-coital interval (≥ 72 hours) in which sperm DNA can be recovered. Detecting a male profile greater than 48 hours after intercourse is of value to forensic casework because in most instances it is unlikely that an autosomal STR profile of the semen donor would be obtainable with vaginal samples taken then.

Extended Interval Post-Coital, Post Amplification Clean Up, Direct Lysis

B97 Mathematical Model of the Real Time PCR Amplification Process Used to Quantify DNA for Forensic Science Applications, Applied Research, Training, and Service at the Biotechnology Center, Shadow Lane Campus, University of Nevada Las Vegas

Walter E. Goldstein, PhD, PE, Adam R. Guilbeault, BS, Tracy R. Welch, BS, and Clarita Kendall, Biotechnology Center UNLV, 1001 Shadow Lane, M/S 7401, Building B, Las Vegas, NV 89106-4124*

After attending this presentation, attendees will have increased understanding of the application of mathematical modeling to the Real Time PCR process used to quantify DNA for the ultimate purpose of human identification. The kinetics of the process will be explained as will the role of inhibitors and reactant supply. The programming and use of reagents during amplification will be explored to learn ways in which the analysis can be improved, for example in dealing with a variety of inhibitors.

This presentation will impact the forensic community and/or humanity by establishing a specialized short term niche training, laboratory service, and applied research in Forensic DNA Profiling. Many of the workshops and services are designed to satisfy specific individual needs of those in the forensic community. From this presentation, attendees will have an increased understanding of both mathematical modeling and also further insight into Real Time PCR and its use. This training is valuable in helping those in the forensic community improve their skills, advance in the profession, or attain a professional position in the forensic community.

In a process that started early in this decade, a new Biotechnology Center has been established at the Shadow Lane Campus of the University of Nevada Las Vegas. Within this Center, a modern Forensic DNA Laboratory is in place that is providing training, laboratory services, applied research, and assisting entrepreneurs in DNA Profiling.

This presentation will cover the derivation and testing of the mathematical model of Real Time PCR for quantitation of DNA. The model will be tested against different patterns in supply of reactants and the presence of different inhibitors encountered in practice. The interplay between inhibitors, reactants, enzyme availability, and kinetics will be used to point out actual effects potentially observed in isolation and amplification of DNA. Recommendations will be provided for use of this information to improve forensic DNA profiling. Suggestions for improving the quantitation assay will be presented.

Mathematical Model, Quantitation of DNA, Real Time PCR

B98 SRM 2372: How the Human DNA Quantitation Standard Was Characterized at NIST and How it Can be Used to Calibrate qPCR Measurements in Your Laboratory

Margaret C. Kline, MS, David L. Duerwer, PhD, Peter M. Vallone, PhD, Amy E. Decker, BS, Janette W. Redman, and John M. Butler, PhD, National Institute of Standards and Technology, 100 Bureau Drive MS 8311, Building 227 Room B226, Gaithersburg, MD 20899-8311*

After attending this presentation, attendees will understand the certification process for SRM 2372 and know how to calibrate Human DNA quantitation materials currently used in their laboratories using SRM 2372.

This presentation will impact the forensic community and/or humanity by educating of the forensic DNA community to the intended

use of SRM 2372; specifically SRM 2372 is intended to enable the comparison of DNA concentration measurements across time and place. Manufacturers can use SRM 2372 to validate the values assigned to their own reference materials. Individual forensic laboratories can use SRM 2372 to validate new DNA quantitation methods as well as to verify the assigned DNA concentration of their in-house calibration standards.

The National Institute of Standards and Technology (NIST) is the National Metrology Institute for the United States of America. NIST's mission is to develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life. To help achieve these goals, NIST develops and distributes Standard Reference Materials (SRMs) for many different measurement systems. SRMs allow laboratories to establish the traceability of a measurement to internationally recognized scales and units.

Approximately 1300 SRMs are currently available for use in basic research and the applied industrial, chemical production, environmental, fire safety, health, and law enforcement communities. NIST SRMs for the forensic and paternity DNA typing communities include SRM 2390 DNA Profiling Standard for RFLP typing, SRM 2391b PCR-Based DNA Profiling Standard, SRM 2392 Mitochondrial DNA Sequencing Standard (Human), and SRM 2395 Human Y-Chromosome DNA Profiling Standard.

This presentation will introduce SRM 2372 Human DNA Quantitation Standard, which has been produced to support the need for human-specific DNA quantitation in forensic casework and calibration of a variety of new quantitative polymerase chain reaction (qPCR) assays now available. Each unit of SRM 2372 consists of three well-characterized DNA extracts; each delivered in a separate screw-capped micro-centrifuge tube. Component A is a single-source human male material derived from blood Buffy coats. Component B is a multiple-source human female material derived from blood Buffy coats. Component C is a multiple-source male and female material derived from Sigma-Aldrich (St. Louis, MO) freeze-dried human placentas. Approximately 120 μL of 50 ng/ μL double stranded DNA is provided in each tube.

The conventional DNA concentration of all three of these materials has been assigned with the U.S. National Reference UV/Visible Spectrophotometer, where an absorbance of 1.0 at 260 nm equals 50 ng/ μL of double stranded DNA. Additional absorbance readings have been made at 230 nm, 270 nm, 280 nm, and 330 nm in order to help characterize the purity of the extracted DNA materials. In addition, an interlaboratory study has been conducted, to verify that the SRM 2372 materials perform well in currently used DNA quantitation assays by the forensic DNA community. A description will be provided for how the information gathered from the interlaboratory study and the detailed homogeneity and stability tests performed at NIST with SRM 2372 are used to define the certified values found on the Certificate of Analysis.

SRM 2372 is intended to enable the comparison of DNA concentration measurements across time and place. Manufacturers can use SRM 2372 to validate the values assigned to their own reference materials. Individual forensic laboratories can use SRM 2372 to validate new DNA quantitation methods as well as to verify the assigned DNA concentration of their in-house calibration standards.

The availability of SRM 2372 provides a Quality Assurance tool for those laboratories that desire to make their DNA quantitation measurements traceable to a National Standard.

Human DNA Quantification, qPCR, Quantitative DNA Standard

B99 Evaluation of the ABI Quantifiler Human DNA Quantification Kit: Optimization of Input DNA for STR Analysis by CE and Determination of a True Zero Value

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After attending this presentation, attendees will retain suggestions for re-validation of CE analysis methods when implementing a new DNA quantitation method. Additionally, attendees will learn useful information about the use of real-time quantitation methods as screening tools for DNA analysis.

This presentation will impact the forensic community and/or humanity by displaying the importance of completing a thorough internal validation prior to implementing new quantitation technologies into the DNA analysis process.

Current methods for the analysis of forensic biological samples commonly require polymerase chain reaction (PCR) amplification of short tandem repeat (STR) loci for human identification using commercial multiplex and megaplex STR kits. Each kit has been optimized by the manufacturer to amplify a narrow range of input DNA, typically 0.50 – 2.50ng. Requiring a narrow range of template DNA necessitates the need for human DNA quantitation methods that are sensitive, precise, and accurate in order to ensure optimal amplification of the STR loci. Recent comparisons of commonly used quantitation methods have shown differences in their sensitivity, accuracy, and/or precision; differences such as these can impact the ability of a laboratory to detect alleles after STR amplification. Therefore, it is important that labs refine their methods and re-optimize downstream procedures in the DNA analysis process as advancements in technologies are made and as new quantitation procedures are implemented. Specifically, failure to revalidate electrophoretic conditions after implementation of a new quantitation method could impact the end result – a successful DNA profile. In this study, the Quantifiler™ Human DNA Quantitation Kit used in conjunction with the ABI Prism® 7000 Sequence Detection System was evaluated to 1) determine the appropriate amount of DNA to be amplified to give optimal heterozygote peak heights during analysis via capillary electrophoresis, and 2) determine if a true zero value exists for this quantitation method – a value below which no detectable STR profile would be observed. Three DNA extraction methods commonly used in forensic casework (organic, the DNA IQ™ System, and the QIAamp® Mini DNA Kit) were used to determine if extraction method had any further influence on heterozygote peak height. All samples were amplified with the AmpF/STR® Profiler Plus™ PCR Amplification Kit, and PCR products of STR loci were separated and detected on the ABI Prism® 3100-Avant Genetic Analyzer. Profiles and heterozygote peak heights were observed using GeneMapper™ ID, version 3.2.

For each of the extraction methods, a strong correlation ($r > 0.80$) between input DNA and heterozygote peak height was observed, however DNA extracted with the DNA IQ™ System consistently resulted in higher peak heights. In addition, the data show increased variability in average peak heights at inputs of >1.500 ng. Based on the data collected, it is recommended that the input DNA for multiplex STR amplification be increased to 1.500 ng of extracted DNA. At this input level, if the volume of PCR product for CE analysis is maintained (1.2 μL) along with a 10sec electrokinetic injection, average heterozygote peak heights near 1500rfu should be obtained. In the true zero value study, 96 low-level DNA samples (ranging from “undetected” to 0.225 ng/ μL) were

amplified using the AmpF/STR® Profiler Plus™ kit. It should be noted that typable loci were obtained from samples that were “undetected” by Quantifiler™, including a complete profile obtained from one “undetected” sample. However, 73% of the time, samples that were “undetected” by the Quantifiler™ kit were truly undetectable, resulting in no typable STR alleles. Although several of the “undetected” samples did display partial profiles, these samples generally did not yield enough typable loci to provide useful information for identification purposes. Given these observations, an absolute true zero value cannot be defined for Quantifiler™, but these data show that it may be a useful screening tool for predicting the success of a downstream STR amplification.

DNA Quantitation, Quantifiler, Capillary Electrophoresis

B100 A Multiplexed System for Quantification of Total Human DNA and Human Male DNA

Jaiprakash Shewale, PhD, Maura Barbisin, PhD, Pius Brzoska, PhD, Robert Green, PhD, Michael Malicdem, PhD, Robert E. Lagace, PhD, Rixun Fang, PhD, and Manohar R. Furtado, PhD, Applied Biosystems, 850 Lincoln Centre Drive, Foster City, CA 94404*

After attending this presentation, attendees will learn about a methodology for simultaneous quantitation of human DNA and human male DNA in forensic biological samples in single PCR reaction using real-time PCR technology.

This presentation will impact the forensic community and/or humanity by demonstrating a real time assay for simultaneous quantitation of human male and total human DNA in biological samples.

Quantification of human DNA in forensic samples is essential for defining input DNA needed for obtaining interpretable STR profiles. Simultaneous quantification of human male DNA and total human DNA in an evidence sample e.g. sexual assault is desirable to reduce the consumption of evidence sample. In this presentation the authors will discuss the performance of a prototype multiplex reaction that amplifies the Y-specific SRY region, the RNA component of RNase P (H1 RNA) and an internal positive control (IPC).

A multiplex assay was designed that amplifies SRY (FAM™ dye-labeled probe), RNase P (VIC® dye-labeled probe), and an IPC (NED™ dye-labeled probe). The multiplex was optimized *in silico* to avoid interactions between the oligonucleotides and minimize formation of primer-dimers. This was confirmed by laboratory testing. The RNaseP and SRY assays were human specific with minimal cross-reactivity to DNA from other species. A control male DNA was used for the generation of standard curves for both assays. The primer and probe concentrations were optimized to ensure that the Y-DNA was detected and quantified accurately in the presence of a large quantity of female DNA. Performance data, including precision, accuracy, and reproducibility, will be discussed. Application to different sample matrices (blood, semen, saliva, vaginal swabs etc.) will be presented.

DNA Quantitation, Real Time PCR, DNA Analysis

B101 A Novel Real Time PCR Method for Evidence Screening That Simultaneously Detects and Quantitates Human Male DNA

Sudhir K. Sinha, PhD, and Anthony Carter, PhD, ReliaGene Technologies, Inc., 5525 Mounes Street, New Orleans, LA 70123*

After attending this presentation, attendees will understand a high through-put sexual assault evidence screening method that is highly reliable and less laborious and time consuming.

There are hundreds of sexual assault rape kits waiting for DNA analysis so that the DNA profile of the rapist can be compared with the

CODIS database. This presentation will impact the forensic community and/or humanity by providing forensic analysts a rapid and high through put method to screen these rape kits to identify the samples which can be further analyzed to produce up loadable DNA profile.

The preliminary screening of forensic evidence samples for the presence of male chromosomal DNA can be one of the most time-consuming and difficult parts of the investigative process. The meticulous task of microscopy requires valuable human resources. Also, quantitation of total DNA and male chromosomal DNA is an extra step that can further consume machine and reagent resources. It is important to conserve forensic evidence therefore, knowing the concentration of DNA gives a limit on how much processing can be performed on a sample. Reliagene Technologies, Inc. has developed a novel forensic sample screening kit that incorporates the ability to simultaneously detect male chromosomal DNA and quantitate the male DNA. Because this system utilizes Real-Time PCR it allows one to amplify, detect and quantitate in only the time it takes to run several cycles. The built-in male DNA quantitation is useful when processing the mixed sample so as to isolate suspect sperm cells from victim epithelial cells. The screening kit methodology is based on detection of human-specific *Alu* insertions that are interspersed throughout the nuclear genome. The *Alu* family of interspersed repeats has a number of advantages as human identity tools that set them apart from STRs. This genetic system enables screening of all types of biological samples on a rapid and sample conservative basis. No differential extraction is needed to evaluate the sample. Further, individual assays can be performed on as little as 10% of the evidence sample and adapted to a 96 well format to facilitate high-throughput screening. Comparative results of screening of sexual assault kits using P30, microscopy examination and Y-DetectRT system will be presented.

DNA Test, Sexual Assault, Evidence Screening

B102 Validation Theory, Interpretation, and Statistical Analysis of DNA Mixtures

John V. Planz, PhD, UNT System Center for Human Identification, 3500 Camp Bowie Boulevard, Fort Worth, TX 76107; and Bruce Budowle, PhD, FBI Laboratory, 2501 Investigation Parkway, Quantico, VA 22135*

After attending this presentation, attendees will understand appropriate methods and basis for DNA mixture interpretation and reporting.

This presentation will impact the forensic community and/or humanity by increasing awareness of the issues that need to be considered when developing and implementing interpretation and statistical guidelines for handling DNA mixtures.

The use of amplified short tandem repeat markers has become the standard for forensic DNA analysis worldwide. Although the community has become highly proficient in typing these marker systems in casework and databasing, a great deal of confusion and inconsistency persists in the interpretation of STR marker profiles in mixtures. The root causes appear to be irregularities in the evaluation procedure, inadequate validation experiments, and/or development of criteria not based on empirical data. These problems lead to apprehension and lack of confidence in the manner in how interpretations and statistics should be applied to mixture data so that reliable, unbiased estimates can be presented to the fact finder. In this presentation the authors will outline and discuss the scientific process to follow based on mixture validation studies, how conclusions can be drawn, and approaches so that statistical weight can be applied without compromising the scientific integrity of the analyst or the process.

Mixtures, DNA, Statistics

B103 An Efficient Approach to Validation of New Technologies in a Forensic DNA Laboratory

Joe Minor, MS, Charles Hardy, Sr., BS, Constance Howard, MS, Chad Johnson, BS, Jennifer Millsaps, MS, Donna Nelson, BS, Loren James, BS, and Sharon Horton-Jenkins, PhD, Tennessee Bureau of Investigation Forensic Services Division, 901 R.S. Gass Boulevard, Nashville, TN 37216; Cortney Boccardi, MA, Catherine Caballero, BS, Mark Miller, MS, and Jonathan Tabak, BA, Applied Biosystems, 850 Lincoln Center Drive, Foster City, CA 94404; Lucy D. Houck, BS, LDH Consultants LLC, PO Box 736, Morgantown, WV 26501; and Charlotte Word, PhD, P.O. Box 5207, Gaithersburg, MD 20882*

After attending this presentation, attendees will learn how the Tennessee Bureau of Investigation (TBI) efficiently validated new technologies while maintaining the productivity of its crime laboratory scientists through partnership with qualified external personnel.

This presentation will impact the forensic community and/or humanity by demonstrating an effective internal validation process which: 1) significantly shortens the time to implementation of new technology, 2) allows crime laboratory scientists to remain focused on casework analysis, thereby preventing unnecessary delays or backlogs, 3) meets all SWGDAM/DAB guidelines and accreditation standards, and 4) provides accurate data enabling the technical manager to confirm robust, reliable and reproducible performance and evaluate performance characteristics and limitations within their laboratory.

The implementation of new technologies is often required in order to improve efficiency and effectiveness in a forensic DNA laboratory. In the case of the Tennessee Bureau of Investigation, it was necessary to bring multiple instrument platforms on-line (Applied Biosystems 3130 Genetic Analyzer and ABI PRISM® 7000 Sequence Detection System) and chemistries (AmpF/STR® Identifiler PCR Amplification Kit, AmpF/STR® ProFiler Plus® PCR Amplification Kit, COfiler® PCR Amplification Kit, Quantifiler® Human and Quantifiler Y Human Male DNA Quantification Kits) at multiple TBI locations (Nashville, Knoxville and Memphis). It was apparent that performing the required validation studies in the traditional manner would have been an extremely time-consuming project involving many forensic scientists at each laboratory site. This would take the scientists away from their primary objective of performing casework analysis thereby increasing turnaround of DNA casework.

Utilizing grant funding from the National Institute of Justice, TBI opted to participate in the Validation Support Services program created by Applied Biosystems. This program, which was shaped with input from numerous entities within the forensic community including NFSTC and NIST, employs several highly qualified independent consultants with in-depth forensic DNA experience. These consultants partnered with crime laboratory management to map out a comprehensive validation plan including experimental design, timelines and reporting deliverables. Once the plan was agreed upon, the validation studies were conducted on-site by AB Field Application Scientists, who, as experienced forensic DNA analysts, possess a strong understanding of validation requirements and objectives. The studies and data analysis were completed with ongoing feedback from crime laboratory management, and the consultant/project manager reported the results back to the crime laboratory technical manager for review and standard operating procedure development. Lab personnel from each site were encouraged to remain informed and engaged in the validation process as much as possible without interfering with their primary casework responsibilities. This experience, coupled with the extensive training that occurred at each site after validation was completed, further streamlined the entire validation, training and implementation experience.

At the Tennessee Bureau of Investigation, the result was a reduced number of forensic scientists involved with the internal validation at each site. Ultimately, the major support provided by this program allowed more time to be spent by crime laboratory scientists processing casework samples while validation studies and statistical analyses were being conducted by qualified external personnel. The final result was the rapid implementation and use of new DNA equipment and typing kits without sacrificing valuable time in the crime laboratory.

An evaluation of this validation project will be presented including lessons learned, critical success factors, and recommendations for future projects.

Validation, Support, New Technologies

B104 A Streamlined Approach to Validating New Forensic DNA Technologies

Ralph Jocham, BS, Gloria Lam, MBA, Sharada Vijaychander, MS, Jacquelyn Benfield, BS, Karen Cormier, BS, and Ravi Gupta, MS, Applied Biosystems, 850 Lincoln Centre Drive, Foster City, CA 94404*

After attending this presentation, attendees will have learned how the application of a novel software package specifically designed for Forensic DNA laboratories will improve the speed and ease of validation and implementing a new technology.

This presentation will impact the forensic community and/or humanity by demonstrating a software solution that will enable laboratories to effectively and efficiently implement new technologies while meeting SWGDAM/DAB recommendations.

As the demand for processing DNA evidence has continued to grow, so has the development of new technologies for DNA analysis. These factors can make it difficult for a crime laboratory to strike a balance between successful case workload management and the evaluation and implementation of new technologies. Laboratory accreditation and Forensic DNA Analyst education require careful assessment and thorough validation studies. Validation studies provide objective evidence help to ensure the generation of robust, reliable, and reproducible data and in turn, confidence in the DNA results.

There is a variety of challenges the Forensic DNA laboratory faces when implementing a new methodology. A common challenge identified by laboratories is a lack of resources available for validation. Laboratories also point to the existence of diverse opinions with respect to validation protocols, sample numbers, and definition of appropriate and effective experiments as notable challenges. These variables have been shown to contribute to extensive validation studies that include unnecessary or excessive tests without the benefit of additional confidence. In addition, data management and analysis are cumbersome processes that are often manual operations or utilize a series of limited tools which analysts have developed on their own.

In order to streamline the validation process as well as meet SWGDAM/DAB recommendations, a software solution was developed by the Human Identity group at Applied Biosystems to include the following unique features:

- Easy to use software program with a simple graphical user interface requiring minimal training.
- Experimental design tools and recommendations that assist laboratories in establishing Forensic DNA-specific validation protocols.
- Integration of all portions of validation and workflow processes including; Automated generation of worksheet and applicable set-up files for quantitation, dilution, normalization, mixture preparation, amplification, capillary electrophoresis and genotyping.

- Validation-specific data analysis and graphing tools that help identify optimal operating parameters and performance characteristics required to establish standard operating procedures and interpretation guidelines.
- Project and documentation management that will enable a laboratory to track the progress of the validation and effectively maintain all validation-associated information for accreditation and/or auditing purposes.

Validation, STR Validation, Data Analysis

B105 Evaluation of the Applied Biosystems

AmpF/STR® MiniSTR Kit for Use With Casework Samples

Timothy P. McMahon, PhD, Jennifer L. Zimdars, MFS, and Demris A. Lee, MSF, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Building 101, 2nd Floor, Rockville, MD 20850*

After attending this presentation, attendees will gain insight into how effectively the AmpF/STR® MiniSTR kit will aid in processing degraded or challenging samples. This presentation discusses results from the evaluation of the MiniSTR kit for reproducibility, sensitivity, mixtures, and use with some challenging nonprobative casework samples and how the results compare to PowerPlex16® and Identifiler™.

This presentation will impact the forensic community and/or humanity by demonstrating to other laboratories the increased sensitivity of the miniSTR kit and its advantages to use with degraded samples without having to resort to Low Copy Number amplification methods.

The Armed Forces DNA Identification Laboratory participated in a study to evaluate the performance of the Applied Biosystems AmpF/STR® MiniSTR kit. The AmpF/STR® MiniSTR PCR amplification kit contains a five dye chemistry, which amplifies 8 autosomal STR loci (D13S317, D7S820, D2S1338, D21S11, D16S539, D18S51, CSF1PO, FGA) and the sex determining marker Amelogenin. The loci span a range of 71 to 283 base pairs. Results of this study and discuss how this kit compared to the Applied Biosystems AmpF/STR® Identifiler® PCR amplification kit and the Promega PowerPlex® 16 amplification kit will be presented.

The study consisted of four components: reproducibility, sensitivity, mixtures, and challenged non-probative casework samples. Reproducibility was tested by amplifying 0.5 ng/5µl of target DNA from four samples along with a negative and positive control (DNA 007). The sensitivity of the kit was assessed using a 2-fold serial dilution of the control DNA from 1 ng to 31.25 pg. The third component was a mixture study that targeted 1ng of input DNA for the following mixture ratios: 0:1, 15:1, 10:1, 3:1, 1:1, and 1:0. The fourth component involved the testing of 18 challenged samples from previously processed AFDIL casework. The samples were comprised of extracts from touched objects (LCN), degraded bone and tissue specimens, and 60-year-old aged skeletal remains which previously generated mtDNA profiles. All experiments were run in triplicate except the non-probative samples. Additionally, AFDIL compared the miniSTR non-probative sample results to the AmpF/STR® Identifiler® and PowerPlex® 16 results obtained for the same samples.

Results demonstrated that the AmpF/STR® MiniSTR kit is highly reproducible and sensitive to 62 pg, which is approximately four times more sensitive than traditional STR kits. Peak imbalance was detected at D21S11, CSF1PO, and D2S1338 in high quality DNA amplicons that was not present with degraded or challenged samples. The miniSTR kit detected mixtures at a 15:1 ratio and more importantly detected the presence of a fourth person in one of the mixed touched samples that was not identified using traditional STR kits. During the non-probative

portion, the miniSTR kit out performed the Identifiler® and Powerplex® 16 kits on challenged and degraded samples including the ability to generate full profiles from 60 year aged bone samples.

In conclusion, the miniSTR kit offers four times the sensitivity of traditional STR kits when processing challenged or degraded samples. This translates into the ability to detect minor contributors in mixed samples (e.g. gang rapes or touched objects), or obtain full profiles from samples that did not generate results from traditional STR kits (i.e. charred remains or environmental challenged remains). The single greatest advantage of this kit is the ability to obtain results without having to go to a low copy number approach, thus alleviating interpretation issues due to elevated stutter, allelic drop in and drop out as well as the need for multiple amplifications. The increased sensitivity is due to a combination of smaller locus sizes and optimization toward challenged samples as seen by the absence of peak imbalance.

The views expressed herein are those of the authors and not necessarily those of the Armed Forces Institute of Pathology, the U.S. Army Surgeon General, nor the Department of Defense.

DNA, Forensic, MiniSTR Kit

B106 Validation and Applications of the ABI 3130 Genetic Analyzer for Forensic Casework Analysis

Alan B. Dixon, MSFS, and Kaajal Patel, MS, Georgia Bureau of Investigation, 3121 Panthersville Road, Decatur, GA 30034; Kristen O. Fripp, MS, Georgia Bureau of Investigation, 925-A Mohawk Street, Savannah, GA 31419; and Ted R. Staples, MS, Georgia Bureau of Investigation, 3121 Panthersville Road, Decatur, GA 30034*

After attending this presentation, attendees will understand the internal validation for forensic casework of a new genetic analyzer platform can be daunting. It is the goal of this presentation to demonstrate possible methods and studies that can be used to validate a multi-capillary instrument such as the ABI 3130 Genetic Analyzer for forensic casework. It is also intended to present some practical considerations related to the instrument.

This presentation will impact the forensic community and/or humanity by demonstrating how the internal validation of methods and instruments is a critical aspect to any forensic laboratory's quality program. The ABI 3130 is a powerful tool for use in forensic DNA casework but is useless without proper validation. Once properly evaluated, the 3130 genetic analyzer will be invaluable in producing quality results in approximately a quarter of the time of the ABI 310 instrument.

The anticipated use for the ABI 3130 will be to decrease the backlog of no-suspect DNA cases. Typically, these cases are processed at the request of submitting agencies with suspect-DNA cases receiving higher priority. With the dedication of the ABI 3130 to the backlog of nearly 350 no-suspect DNA cases, the anticipated increase in productivity will be approximately 12-fold.

The internal validation for forensic casework of a new genetic analyzer platform can be daunting. It is the goal of this presentation to demonstrate possible methods and studies that can be used to validate a multi-capillary instrument such as the ABI 3130 Genetic Analyzer for forensic casework. It is also intended to present some practical considerations related to the instrument.

With ever-increasing caseloads and backlogs in state crime labs, the need for rapid and efficient genetic analysis has become critical. High throughput instruments such as the Applied Biosystems 3130 Genetic Analyzer have been developed to meet this need for both fragment and sequencing analysis. Along with its four capillary arrays, the 3130 Genetic Analyzer has an Automated Polymer Delivery System enabling

reduced analysis time and instrument maintenance. Before the ABI 3130 Genetic Analyzer could be operational in a forensic casework setting at the Georgia Bureau of Investigation headquarters laboratory, the instrument had to be internally validated. Utilizing the QAS document, ISO 17025 guidelines, ASCLD-LAB guidelines and Georgia Bureau of Investigation quality documents, a validation study was developed and performed to demonstrate the instrument's ability to produce reliable and accurate results for forensic casework analysis. This study included analyzing known and non-probative samples as well as precision, reproducibility, mixture, and sensitivity studies. Other aspects of the 3130 instrument including capillary to capillary sensitivity, injection times, contamination, amplicon load, and software (data collection and genotyping) settings had to be evaluated. All samples were amplified using the AmpF/STR® Identifiler® Kit (*Applied Biosystems*) and genotyped with GeneMapper ID v3.2 software (*Applied Biosystems*) with a relative fluorescence unit (RFU) threshold of 150.

Known samples consisting of blood, saliva, and semen as well as non-probative evidence samples consisting of epithelial portions from differential extractions all produced the correct genotypes when compared with Profiler Plus and COfiler genotypes. The 3130 instrument produced quality results in regards to precision, reproducibility, and sensitivity, although the 310 platform (*Applied Biosystems*) produced slightly better results in precision and sensitivity studies. Precision data exhibited standard deviations well below the +/- 0.5 base pair sizing standard with higher standard deviations observed at larger loci. Sensitivity data revealed a recommended range of 0.5 to 4 nanogram starting template DNA. However, it should be noted that the 0.25 nanogram template produced partial profiles that may, in certain instances, provide valuable information. Secondary donor profiles could be determined in mixture samples at dilutions of 1:10, 1:3, and 1:1. The 1:20 dilution showed little to no secondary donor alleles that were not considered stutter. Contamination was not detected during the course of the validation experiment even in the presence of overloaded samples. Although peak height differences were evident between capillaries, overall sensitivity was nearly identical between capillaries.

Internal validation of methods and instruments is a critical aspect to any forensic laboratory's quality program. The ABI 3130 is a powerful tool for use in forensic DNA casework but is useless without proper validation. Once properly evaluated, the 3130 genetic analyzer will be invaluable in producing quality results in approximately a quarter of the time of the 310 instrument.

The anticipated use for the ABI 3130 will be to decrease the backlog of no-suspect DNA cases. Typically, these cases are processed at the request of submitting agencies with suspect-DNA cases receiving higher priority. With the dedication of the ABI 3130 to the backlog of nearly 350 no-suspect DNA cases, the anticipated increase in productivity will be approximately 12-fold.

ABI 3130, Validation, Multi-Capillary

B107 Evaluating Casework Profiles When Traces of DNA Are Detected In the Reagent Blank

Kelly Jo A. Walden, MSc, Susanne Holy, MSc, Jack Laird, MSc, and Jonathan Newman, BSc, Centre of Forensic Sciences, 25 Grosvenor Street, Toronto, Ontario M7A 2G8, Canada*

After attending this presentation, attendees will learn quality based guidelines for evaluating the impact, on casework DNA profiles, when low levels of DNA are detected in the associated reagent blank. The presence of trace DNA in a reagent blank does not necessarily invalidate the associated case sample results.

This presentation will impact the forensic community and/or humanity by demonstrating a quality approach for assessing the overall impact on forensic casework samples of low level DNA contamination in reagent blanks.

In forensic DNA analysis, a reagent blank is processed within a batch of case samples as a negative control, to expose the possible presence of contaminating DNA. A reagent blank consists of all the reagent components of the extraction process, without the added DNA. Possible sources of contamination include the reagents themselves, the staff handling the samples, the equipment, or the consumables used within a laboratory. While a quality assurance program ensures that procedures are designed to minimize the risk of sample contamination, no system is effective in completely eliminating this risk. Forensic DNA analysis has evolved into a very robust, sensitive DNA detection system; therefore it should not be unexpected to occasionally find traces of DNA in negative controls. The key is to develop a mechanism to evaluate the impact of a contaminated reagent blank on casework samples.

At the Centre of Forensic Sciences (CFS), a reagent blank for a particular extraction batch is treated exactly the same as the sample within the batch that has the lowest amount of amplifiable DNA. For instance, if the sample with the lowest amount of amplifiable DNA in an extract volume of 15 µL must be concentrated to 6µL for amplification (in a 15 µL total amplification volume), so too would the reagent blank. On the other hand, if the sample with the lowest amount of amplifiable DNA in an extract volume of 15 µL requires dilution prior to amplification, the reagent blank would be diluted to the same extent. The reagent blank is carried through the entire process, from extraction through to detection.

Occasionally trace amounts of amplified product are detected, most often when a reagent blank is concentrated prior to amplification. The product detected usually ranges from a single peak to two or three peaks. In most of these instances, the corresponding case sample that requires this treatment is one with a minimal amount of DNA, all of which must be committed to the amplification. However, many more samples within the same batch may not require this treatment. Hence, the degree to which the ensuing result in the blank may have an impact on the interpretation and reporting of the case profile is dependent on a number of factors which vary sample by sample throughout the batch.

The CFS has developed guidelines for reporting DNA profiles from batches where a trace amount of DNA has been detected in the reagent blank. The key question is whether a low level of DNA, such as that observed in the reagent blank, would be detectable in the case sample. The following factors must be considered: the total amount of DNA detected within the case sample and hence the manner in which it was treated in preparation for amplification, the amount of DNA actually amplified the appearance of the ensuing profile, and the possible presence of corroborating findings from other samples within the same case. There are two possible outcomes to the evaluation of a reagent blank contaminant in relation to the quality of the casework profiles. Based upon the four factors described above, one can either exclude an impact or not. When one is able to exclude an impact, then the quality of the casework profiles is not at issue and these are reported in the normal fashion, with the rationale documented in the case file. When, on the other hand, one is not able to exclude a possible impact, then additional work is undertaken where possible, including reanalysis or resampling. If ultimately one is still not able to exclude an impact, then this finding is indicated in the report sent to clients. In this presentation actual examples of both outcomes, drawn from casework experience, will be discussed.

The approach that has been developed at the CFS for dealing with low levels of DNA in the reagent blank is scientifically sound and faithful to the principles of an open and effective quality system. In fact, the implementation of these guidelines has improved the CFS quality system by ensuring that evaluations of controls are based on their scientific merit rather than on an arbitrary all-or-nothing basis.

Contamination, DNA Analysis, Reagent Blank

B108 Genetic Identification of Improvised Explosive Device Assemblers

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After attending this presentation, attendees will become familiar with best methods for obtaining genetic evidence from detonated pipe bombs and other types of improvised explosive devices. Attendees will also learn the most effective technique of analyzing DNA obtained from these devices.

This presentation will impact the forensic community and/or humanity by increasing the understanding of what happens to DNA on improvised explosive devices after they have detonated, and how it can be used to identify those who assembled them.

This presentation will include information regarding the collection and analysis of DNA from detonated improvised explosive devices (IEDs). The goal of the research is to determine the most effective way of identifying the person or persons involved in assembling an IED.

The detonation of an IED produces very high temperatures. These temperatures, in combination with the general nature of the genetic material from shed skin cells, result in highly degraded DNA. As a result, earlier research showed that it is very difficult to obtain full STR profiles on DNA isolated from detonated pipe bombs.¹ Therefore, mitochondrial DNA (mtDNA) analysis was undertaken. Subjects were asked to mock assemble pipe bombs for a short period of time, after which they were taken to a safe facility and detonated. The DNA was isolated from the resultant shrapnel, quantified using real time PCR, amplified, and the mtDNA sequence determined. Based on the sequencing results, eighteen of the thirty eight samples could be assigned to a single donor and seven more could be assigned to a subset of three possible donors, while only twelve bombs could not be assigned to any individual. These results demonstrate the value of mtDNA analysis for suspect identification.

Although mtDNA analysis is valuable, it is not individualizing as evidence, hence nuclear DNA testing is preferred in many instances. Owing to the earlier results with full length STRs, mini-STR profiling was attempted on detonated bombs in an effort to develop a CODIS profile. Another technique which can be applied to degraded nuclear DNA is single nucleotide polymorphism (SNP) analysis. This technique looks at many single nucleotides where polymorphisms are known to occur. Because only a single nucleotide is observed, the fragments of DNA utilized do not need to be large. This presentation will show results of the various techniques that can be used to analyze DNA to identify assemblers of pipe bombs.

Finally, although pipe bombs are the most common type of IED in the US, there are an increasing number of other types of IEDs that are being utilized. One of the simplest and most common is the use of high explosives in an otherwise unsuspecting container such as a backpack or canvas bag. The use of these devices poses new questions with regards to the collection and analysis of DNA from such surfaces. Unlike pipes which are made of smooth, impermeable materials, backpack and bags are often made of rough, porous fabric. This presentation will include the techniques which are most successful for obtaining DNA from surfaces such as these after the explosion has occurred.

Reference:

¹ Esslinger, K.J., Siegel, J.A., Spillane, H., Stallworth, S. (2004) Using STR Analysis to Detect Human DNA from Exploded Pipe Bomb Devices, *J.Forensic Sci.*, 49(3):481-484.

DNA, Improvised Explosive Device, Pipe Bomb

B109 Evaluation of Alternative Methods to 16S rRNA Gene Sequence Analysis for Microbial Forensic Applications

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After attending this presentation, attendees will have learned about broad-range PCR-based assays for improved identification of bacterial species, how additional bacterial gene targets can be used to perform sequence analysis where other methods are insufficient, and how this type of assay can be applied in a variety of fields, including microbial forensics.

This presentation will impact the forensic community and/or humanity by demonstrating how more discriminating techniques for bacterial identification and additional gene sequence information allow more definitive information to be obtained and used for source attribution during investigation of an outbreak, biocrime, or bioterrorism event. These also provide a strong foundation for the development of future methods of strain typing or fingerprinting similar to human forensic STR analysis.

In the wake of the 2001 anthrax letter attack, the field of microbial forensics has been propelled into the spotlight. Increasing interest in biodefense and clinical microbiology applications for current outbreak, bioterrorism and biocrime analysis has necessitated method improvement. These have centered on identification and differentiation of pathogens to species and even strain levels. As an emerging field, much work is needed to prepare microbial forensics for the scrutiny of current forensic standards. One area of improvement involves the development of more discriminating identification methods, with the ultimate goal of source attribution. Inherent variation and short generation times result in nucleotide differences among bacterial gene sequences, complicating the process of matching species or strains. These discrepancies, often understood and accepted within the microbiology field, pose a challenge when considered from the legal aspect of microbial forensics. Inherent uncertainties are difficult to explain to judges and juries as convincing evidence. Methods utilized in a microbial forensic investigation must also withstand *Daubert* and *Frye* tests for admissibility as valid evidence attributed to a biocrime or act of bioterrorism. This requires continued research to improve identification methods to ensure microbial forensic techniques are comparable to the current stringent regulations for DNA-based tests for human identification. Recent molecular sequencing work performed in bacteriology and molecular development labs is an important starting point for continued work to prepare microbial forensics for scrutiny by the forensic and legal communities. Improved methods are also necessary to facilitate diagnosis and treatment of these bacteria in clinical microbiology and public health settings.

Broad-range PCR methods are useful for bacterial identification as culturing some species is extremely slow, time-consuming, or even impossible in the lab. Inexact biochemical analyses are not always specific enough to make a confident identification and comparison based upon sequencing of the 16S rRNA gene for many species. *Streptococcus* and *Bacillus* species include human bacterial pathogens that cannot be completely and efficiently identified by these current available diagnostics. At the New York State Department of Health's Wadsworth Center, many clinical isolates of these species analyzed by the traditional 16S rRNA gene sequence analysis demonstrate significant nucleotide sequence similarity within this gene. Additional broad-range PCR assays are needed to allow further discrimination of these species as agents of nosocomial, community, or food borne outbreaks, or even bioterrorism.

This study, performed at the Wadsworth Center, evaluated alternative gene targets *cpn60*, *tuf*, and *rpoB*, in broad-range PCR-based assays with *Streptococcus* and *Bacillus* for nucleotide sequence variation among species. Gene sequences with greater variation will allow improved discrimination and identification of the clinical isolates of these species received by this reference laboratory. Both published and novel primers were used for amplification of the target genes. Sequence analysis of these amplicons demonstrated an increase in nucleotide variation among species compared to their *16S rRNA* gene sequences. A preliminary blinded assay exhibited successful identification of *Streptococcus* and *Bacillus* species tested with primer sets for these target genes. Continued work including optimization and blinded validation analysis must be performed with the primer sets in progress for these species.

The design of improved methods for conclusive identification and classification of bacterial pathogens is a crucial step towards confident attribution of a species or strain as the source of any type of biological incident. The creation of databases containing sequence information obtained through this work will be implemented for future use at the Wadsworth Center. These databases will assist in the development of improved techniques for both clinical microbiology and microbial forensic applications. Obtaining additional gene sequence information provides a foundation for future methods of strain typing or fingerprinting more similar to human forensic STR analysis. Collaboration for continued advances with these assays will ensure the fields of epidemiology, microbiology, and microbial forensics are prepared to meet the challenges facing investigation and source attribution of biological events.

Microbial Forensics, Broad-Range PCR, Gene Sequence Analysis

B110 Plant Poaching

Robert D. Blackledge, MS, 8365 Sunview Drive, El Cajon, CA 92021; and James E. Corbin, BA, North Carolina Department of Agriculture & Consumer Affairs, Sylva, NC 28779*

After attending this presentation, attendees will understand the scope of the international/national problem of plant poaching; the international/national conventions and statutes pertaining to plant poaching; the elements of the crime of plant poaching; and the role of the criminalist in the prosecution of plant poaching cases.

This presentation will impact the forensic community and/or humanity by increasing awareness of the international scope of plant poaching, the conventions and statutes that may apply, the elements of the crime (what the prosecution must show), and the role of criminalists in the marking, detection, and identification of plants subject to theft.

The theft and trade in endangered, exotic, and commercially valuable plants is a huge national and international problem. The international forensic science community needs to become aware of this problem, to exert their expertise towards the prevention of plant poaching, and to provide means of detection and identification of poached plants so that violators may be successfully prosecuted. The audience will be told of the scope of this problem, illustrated by a few specific cases. They will also be made aware of the applicable major international/national conventions and statutes, and the elements of the crime that must be proved if prosecution is to be successful. Specifically of interest to criminalists, the talk will conclude with marking/detection/identification methods that have led to successful prosecutions, and offer hints of future approaches.

Plants, Poaching, Detection

B111 Food Microscopy for Forensic Scientists

Scott F. Stoeffler, MSFC, McCrone Associates, 850 Pasquinelli Drive, Westmont, IL 60559*

After attending this presentation, attendees will understand microscopical techniques for characterizing and identifying a variety of foods and food-related materials.

This presentation will impact the forensic community and/or humanity by providing information and education on a somewhat neglected area of trace evidence, for which training is rarely available.

The goal of this presentation is to acquaint forensic scientists with microscopical methods for the identification of various common food products, either in bulk, or as stains or traces. Characteristic features of a variety of foods and food-related materials will be described.

Food products and related materials such as herbs, spices, and seasonings are occasionally encountered as trace evidence, in stomach contents or in cases of adulteration. A great deal of information about such materials can be gained by examination using the stereomicroscope and polarized light microscope, and in many cases, identification is possible without the need for more involved chemical analysis.

Many powders and other dry materials can often be identified by simple visual examination under a low power stereomicroscope. Products such as herbs, spices, coffee, and tea have distinctive morphological features that allow them to be identified definitively, with the use of appropriate reference materials. Further examination of optical properties with the polarized light microscope can provide more specific identification of materials such as starches and other white powders. Starches are easily recognized by their distinct black cross between crossed polars, and examination of shape, size, hilum appearance and surface striations can help to identify specific varieties. Crystalline materials such as salt, sugar, and baking powder can be identified by their morphology, refractive indices, and other optical properties. Stereomicroscopy and polarized light microscopy are also useful for the identification of mixtures.

In some cases, suspected food materials cannot be specifically identified, but microscopical features can provide general information about the class of material present. Light microscopy can help to identify the presence of pigments such as chlorophyll, lycopenes, and carotenes, which are characteristic of particular types of plant material. A variety of staining techniques are available for distinguishing fat, protein, and carbohydrate components and for eliciting the microstructure of food products. The presence and distribution of fats and oils in a sample can be determined through the use of a specific stain such as Oil Red O or ruthenium tetroxide. Intact starch grains can be stained using a classic iodine solution or iodine vapor, while cooked starch and other carbohydrates, as well as meat products, can be differentially stained using toluidine blue.

Microscopy, Food, Trace Evidence

B112 Forensic Analysis of Flesh and Flavor Compounds in Stone Fruits

Chin-Chin Lim, MSc, MBA, Poh Ling Chia, BSc, Irene Tan, Wanjing Su, and Michael Ming Kiong Tay, PhD, Centre for Forensic Science, Health Sciences Authority, 11 Outram Road, Singapore, Singapore 169078, Singapore*

After attending this presentation, attendees will learn to select and apply appropriate analytical techniques to identify fruit pulp and juice stains and residues in a forensic context.

This presentation will impact the forensic community and/or humanity by drawing attention to the possibility of identifying fruit stains and residues in a crime scene, so as to reconstruct events and corroborate or refute allegations.

In forensic investigations, unknown stains are sometimes found on non-porous surfaces such as floor tiles, furniture, and utensils and on porous materials such as clothes, carpets, upholstery, and facial tissues. Techniques are readily available for stains of various organic and inorganic substances, and stains containing biological materials (blood, seminal and vaginal fluids, urine). The identification of fruit stain traces and residues has attracted little, if any attention in the forensic community.

The identification of a fruit residue or stain is useful to the forensic field as these substances may emerge as crucial evidence in understanding events surrounding the commission of a crime. They may be left at crime scenes and even in the stomach contents of murdered victims. The detection and identification of these substances could be vital in linking a suspect or victim to the crime scene or in establishing circumstances in the crime. The reconstruction of events provides valuable insights to the judge and jury of the mind, motive, and responsibility of the defendant.

The detection and identification of fruit stains and residues pose a significant analytical challenge due to the dynamic nature of the fruits and the complex environmental conditions. Whole fruit juices are usually 80-90% water. Juice expressed from fruit during cutting and squeezing contains natural sugars, vitamins, minerals, phytochemicals, organic acids, and aroma flavor compounds. Many fruit flavor and fragrance compounds are volatile or semi-volatile. Small volumes of juice leave little residue on drying. According to the literature, aroma volatile compounds are influenced by many factors including the species, cultivars, locations, seasons, fruit maturity at harvest, processing, and storage and ripening conditions. On exposure to air, cut or bruised fruit begins to darken and turn brown with oxidation, fermentation, and chemical reaction. Microbes, fungi and other microorganisms, ubiquitous in the environment, cause rapid spoilage in hot weather. Environmental conditions such as temperature and exposure effects also alter the chemical composition of the original fruit.

The aim of this research was to examine the usefulness of different analytical techniques and propose analytical schemes for the characterization of stone fruit pulps, residues, and stains. Seven different types of stone fruits were examined: mangoes, peaches, nectarines, cherries, plums, olives, and jujubes. The techniques used include screening with UV-VIS light, microscopy, Raman microscopy, Fourier Transform-Infrared (FT-IR) microscopy, and gas chromatography-mass spectrometry (GC-MS). Findings indicated that:

1. Fruit stains could be located by screening with light of 445 or 455 nm.
2. Microscopic examinations yielded information on the fibrous nature of the fruit pulps.
3. Raman microscopy and FT-IR microscopy were able to identify the non-volatile compounds (glycerol, sugars, oil, carotenoids) in the fruit pulps, residues, and stains but could not clearly differentiate different types of stone fruits.
4. GC/MS was useful for characterizing the volatile compounds in the fruit pulps and residues but it has its limitations for characterizing fruit stains, especially stains deposited on non-porous surfaces. The flavor and fragrance compounds of stone fruits were first extracted using either solvent extraction or passive headspace carbon strip adsorption techniques. The aroma volatile compounds detected using GC/MS include organic acids, alcohols, aldehydes, terpenes, esters, ketones and lactones. The comparison of chromatographic profiles (total ion chromatogram and extracted ion profile) of the unknown substance and the known cultivar would provide confirmatory information on the likely source of origin of the unknown substance.

Stone Fruits, Flesh and Flavor Compounds, Volatile and Non-Volatile

B113 DNA Transfer Through Forceful Contact

Victoria L. Bowyer, MSc*, Eleanor A.M. Graham, MSc, and Guy N. Ritty, MD, MBBS, MD, Forensic Pathology Unit, University of Leicester, RKCSB, Leicester Royal Infirmary, Leicester, Leicestershire LE2 7LX, United Kingdom

After attending this presentation, attendees will find out whether offender DNA can be detected in sites of forceful contact and how the profiles observed vary between different types of force. This may be an important tool in those investigating physical abuse in men, women and children.

This presentation will impact the forensic community and/or humanity by indicating whether it is possible to identify the perpetrator of physical abuse or rape by swabbing areas of known forceful contact for offender DNA.

Hypothesis: DNA will be deposited on an individual's skin when punched, slapped, or gripped, although the quantity/quality will vary depending on the force applied. DNA from the 'victim' will also be observed on the hand of the donor.

The British Crime Survey of 2001 found that approximately 45% of women and 26% of men aged 16 to 59 had experienced at least one incident of inter-personal violence in their lifetimes. In Britain every year three million children are victims of abuse. Many victims are too terrified to tell the authorities what has happened, and without their testimony or the evidence of witnesses it may be impossible to identify the perpetrator and prosecute them.

A number of studies including those by van Oorschot *et al.* (1997), Lowe *et al.* (2002) and Ladd *et al.* (1999) have shown that it is possible to obtain a DNA profile from objects, touched even for only a few seconds. As yet, the only investigation into the transfer of DNA through forceful contact is that by Ritty (2002). This study showed that during simulated manual strangulation 7 out of 19 test swabs showed victim and offender DNA profiles, with the offender profile being observed up to 6 hours after contact. Twelve out of the 19 showed victim only DNA profiles. No other study, as yet, has investigated different forms of forceful contact. It is hypothesized, therefore, that when an individual hits another, some of the offender's DNA will be transferred onto that person's skin and vice versa.

A preliminary study has been performed to investigate the transfer of DNA between individuals during a punch, slap, and brief grip of the upper arm. Of the two individuals involved one was known to be a poor shedder, and the other a good shedder, but experiments were performed at least one hour after hand washing in order to minimize the effects of shedder status (Lowe *et al.* 2002). Prior to each contact the volunteer's arms and hands were swabbed as a control (the opposite ones to those involved in the contact). After the force was applied the hand of the donor was swabbed and the recipient's arm was also swabbed with a sterile moistened cotton swab. This was then repeated with the roles reversed. Each experiment was carried out with a punch, slap, or grip and each type of force was tested three times.

DNA was extracted from the swabs using the Qiagen QIAamp DNA mini kit (Qiagen Ltd, Sussex) and was quantified using the Nanodrop® ND 1000 spectrophotometer. DNA was amplified and analyzed using AmpF®STR? SGM Plus? PCR Amplification kit, ABI 3130 genetic analyzer, and Genemapper IDâ (Applied Biosystems, CA, USA).

After 28 cycles of PCR no non-donor alleles were observed, on the arm or hand of either volunteer. Thirty-four cycles of PCR did result in one or two spurious alleles but only one sample yielded a mixed profile. This sample was from the arm of one of the volunteers after being slapped and showed alleles from donor and recipient at multiple loci.

References:

- 1 van Oorschot, R.A. and Jones, M.K. (1997) *Nature*, 387, 767.
- 2 Ladd, C., Adamowicz, M.S., Bourke, M.T., Scherzinger, C.A. and Lee, H.C. (1999) *J Forensic Sci*, 44, 1270-1272.
- 3 Lowe, A., Murray, C., Whitaker, J., Tully, G. and Gill, P. (2002) *Forensic Sci Int*, 129, 25-34. Ritty, G.N. (2002) *Int J Legal Med*, 116, 170-173.

DNA, Force, Physical Abuse

B114 Investigation Into “Normal” Background DNA Present on the Adult Neck: Implications for DNA Profiling of Manual Strangulation Victims

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The goal of this presentation is to demonstrate that background levels of non-donor DNA are regularly observed on the neck surface of normal healthy adult volunteers and that this ‘contamination’ can be found in sufficient quantity to effect DNA profiling after physical assault.

This presentation will impact the forensic community and/or humanity by demonstrating that sufficient DNA profiling can be used as an investigative tool for offender identification in cases of assault, such as manual strangulation. This technique could therefore be of benefit to assault victims around the world. The possibility of recovering non-offender DNA should however be considered and in some cases may render this technique unusable. A multi-faceted approach that does not solely rely upon DNA profiling is therefore recommended for offender identification.

Hypothesis: Current theories on DNA transfer between individuals and inanimate objects state that the DNA profile recovered would be from of the last person to contact the area of interest, and that all other previous traces will be replaced by the most recent contact. This area of DNA profiling is still not fully understood. In order to test this theory further, a set of partially controlled experiments to determine whether total DNA profile replacement can be achieved on a purposely contaminated skin surface.

Content: It has previously been demonstrated that after simulated manual strangulation, offender DNA can be detected on the neck surface of the victim (Rutty, 2002). Although this study highlighted the possibilities of applying DNA profiling to offender identification, it did not consider the background levels of DNA that may be present on the neck surface of adults before an assault has taken place. Twenty-four healthy adult volunteers were recruited to participate in this study. All volunteers completed a questionnaire to provide information pertaining to recent activities such as washing of the neck, contact with other individuals e.g. partners. The use of make-up and perfume was also considered. Swabbing of five areas was performed on all twenty-four volunteers. Additionally, ten volunteers were asked to participate in a follow-up study to investigate the influence of background DNA contamination on the investigation of physical assault. Similarly to Rutty 2002, manual strangulation was simulated by application of moderate force to the neck surface. Swabbing was performed before contact and volunteers were asked to return 24 hours after this contact period for re-sampling.

Methods: Samples were collected using sterile cotton swabs moistened with sterile water using a brushing motion. DNA extraction was performed using the Qiagen DNA mini kit (Qiagen, West Sussex, UK) following the swab protocol. Quantification was performed using the Nanodrop - 1000 Spectrophotometer (DNA was amplified and analyzed using AmpFiSTR® SGM Plus® PCR Amplification Kit, ABI PRISM® 377 DNA Sequencer, Genescan® and Genotyper® (Applied Biosystems, Foster City, CA, USA).

Results: Sufficient DNA can be recovered from the neck surface for DNA profiling to be carried out. The quantity of DNA varies greatly both between different individuals and areas of the neck. Non-donor contaminating alleles were found on 23% of all swabbed sites, of which 5% contained enough information for a positive identification to be confidently assigned, without further investigation. It was also noted that more areas of contamination were detected on volunteers with partners than single individuals. Results of contact experiments showed

that victim, offender and non-offender DNA could be recovered from the neck surface 24 hours after the contact was made.

Conclusion: DNA profiling should be considered as an investigative tool for identification of the perpetrators of assault, such as manual strangulation. The possibility of collecting non-offender DNA should however be considered, especially if the victim has recently been in physical contact with any other individual(s).

DNA, Contamination, Manual Strangulation

B115 Application of Microscopy in Forensic Science Training, Applied Research, and Service at the Biotechnology Center, Shadow Lane Campus, University of Nevada Las Vegas

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After attending this presentation, attendees will have increased knowledge of the principles of microscopy and equipment used in processing of human samples and processing aids associated with human identification. The use of microscopic techniques to stimulate creative thinking in research, service, and training will be presented. Information and pictorial aids will be presented to demonstrate the impact these microscopy techniques have on Forensic DNA Profiling for human identification.

This presentation will impact the forensic community and/or humanity by establishing specialized short-term niche training, laboratory service, and applied research in Forensic DNA Profiling. Many workshops and services are designed to satisfy specific individual needs of those in the forensic community. From this presentation, attendees will have an increased understanding of microscopy and its use in this area. This training is valuable in helping those in the forensic community improve their skills, advance in the profession, or attain a professional position in the forensic community.

In a process that started early in this decade, a new Biotechnology Center has been established at the Shadow Lane Campus of the University of Nevada Las Vegas. Within this Center, a modern Forensic DNA Laboratory is in place that is providing training, laboratory services, applied research, and assisting entrepreneurs in DNA Profiling.

This presentation will cover the use of light microscopy, including observation under different degrees of optical magnification, brightfield (stained samples), phase contrast (unstained samples), polarized light (samples exhibiting birefringence), fluorescence (samples exhibiting auto-fluorescence) and differential interference contrast (a high resolution contrasting method), to augment knowledge, data, and observations as DNA is isolated, quantified, amplified and analyzed. Specific images of samples typical of sexual assault, blood, clothing, teeth, bone, and a variety of cells will be presented and discussed as alternative sources of DNA. DNA results from analysis of such samples and processing aids in extraction and purification will be presented in association with microscopic images. The images presented and methods discussed will include differentially-stained post-coital samples, confirming the presence of spermatozoa in a known male/female mixture, and differentially stained images following the digestion of epithelial cells to confirm presence of sperm heads only.

Microscopy, Forensic DNA Profiling, Differentially-Stained Images

B116 Northeast Regional Forensic Institute, 12 Week, 12 Graduate Credit Hour Academies (DNA Casework, Databank, and Serology)

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After attending this presentation, attendees will be aware of an innovative DNA academic program as an alternative to traditional mentor training. An academic based 12 week, 12 graduate credit hour, DNA Casework, Databank, and Serology academies prepare new forensic scientists for casework. Individual modules can also be used for professional development.

This presentation will impact the forensic community and/or humanity by providing alternatives to traditional mentor training. Many forensic laboratories are lacking the resources (facilities, equipment and staff) needed to provide training for new employees and professional development. Forensic technologies change rapidly. Academic based curriculums within designated laboratories staffed by educators and forensic scientists are producing favorable results and efficiencies. Policy makers need information on the positive impacts derived from education on the quality and productivity of forensic services.

This presentation will describe the newly revised curriculum and staffing model for the DNA Academy designed for New York State. NERFI has now developed and implemented a separate 12-week, 12 graduate credit hour curriculums for DNA Casework, Databank, and Serology. The process used to develop support for the DNA Academy programs as a result of an expansion of the New York State DNA Databank will be discussed. An update on the changes made to the NERFI DNA Academy program (at least five DNA Academies will be completed by February 2007) including feedback from client agencies will be provided. The collaboration between the University at Albany Forensic Molecular Biology program and the NERFI DNA Academy will be described to show the benefits of partnering with the academic community. Collaboration with the New York State Police Forensic Investigation Center is further exemplified in the essential integration of the University at Albany computer network with the New York State Police Laboratory Information Management System. All students perform at least twice the number of analyses required by the Scientific Working Group DNA Analyses Methods guidelines.

Conceived as a center for forensic academic excellence, the NERFI addresses a critical and ongoing need to produce highly trained, case-ready technical personnel for careers in forensic laboratories. NERFI will foster collaborations between local, state, and federal criminal justice agencies and other academic institutions to develop forensic programs in education, research, and outreach. The DNA Academy program was designed to provide a solution to address the nationwide shortage of forensic scientists. The explosive growth of DNA technology in the field of forensic science has created critical casework backlogs in all public and private forensic laboratories. Traditionally, the overwhelming majority of forensic laboratories have been forced to use one-on-one mentor training for new employees and very little professional development opportunities are available for existing employees. Mentor training and competition for casework instruments decreases laboratory efficiency and potentially eliminates the mentor's productivity. The NERFI DNA Academy replaces the conventional one-on-one mentor 12 month training programs with a dedicated state of the art forensic training facility, university approved 12 week, 12 graduate credit hour curriculum, staffed with SUNY Albany faculty and nationally renowned visiting scientists. Students successfully completing the DNA Academy will earn 12 credit hours of graduate course work. More importantly, the newly trained scientists will also

meet all mandated state, national, or international accreditation standards for forensic laboratories.

The curriculum from the Graduate program in Forensic Molecular Biology has provided the courseware framework for the DNA Academy. The University at Albany was one of the first in the Northeast to deliver a 40 credit Graduate Program in Forensic Molecular Biology. Overall, this program has been very successful. The program is now in its fifth year and graduates have proceeded to placement in many private laboratories, public laboratories, and Ph. D. programs.

The DNA Academy curriculum consists of four modules that deliver 12 graduate credits hours of academic course work. There is now a 12 week / 12 graduate credit hour curriculum for Casework, Serology, and Databank. Individual modules of the curriculum are used to provide professional development for experienced scientists. Module 1 is a one credit hour, 1-week long lecture component that provides the latest theories of forensic DNA technologies. A digital library of all pertinent reference materials and interactive video conferencing will be used for the distance-learning module. Module 2 and 3 (10 credit hours), consist of 8 weeks of laboratory instruction held at the University at Albany. The "Mirror Laboratory" concept is continuously updated to employ the latest technologies currently in use in all forensic laboratories. The students will analyze evidentiary samples that are identical to the items received at crime scenes and submitted to forensic laboratories. For example, bloodstains on all types of substrates will be recognized, collected, amplified, and analyzed by identical instruments and techniques used in forensic laboratories. A one-week module covering instrumental theories, trouble shooting and maintenance and one week of statistics is delivered between Module 2 and 3. Moot court, one credit hour, will then be used to measure the competency of all students as per national accreditation guidelines. Individual segments of the program will also be used to provide professional development programs that are mandated by New York legislative and international accreditation criteria. The graduates of the program will be competent to analyze a variety of evidentiary items routinely submitted for DNA analyses when they return to their home laboratories.

Forensic Education, DNA, Academies

B117 Exploring Forensic Scenarios With TrueAllele® Mixture Automation

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After attending this presentation, forensic scientists will understand how they can easily conduct multiple "what if?" computer analyses in order to explore mixed DNA profiles and matches under different forensic scenarios.

This presentation will impact the forensic community and/or humanity by demonstrating DNA review of sexual assault cases is currently hampered by the difficulty of scientific interpretation and matching. There is arduous manual interpretation effort that must be performed within a limited time frame for each case. This means that usually a person can seriously examine only one case scenario. With the advent of computer automation of DNA mixture problems, it becomes possible to provide forensic scientists with a flexible tool that permits easy exploration of multiple forensic scenarios. The forensic scientist can now explore underlying forensic issues, handing off to their computer assistant the numerical calculations of each scenario.

In current forensic practice, DNA mixture data review is often not an enviable task. Forensic scientists typically spend many hours considering just one subset of the data, expending considerable effort to obtain limited genetic identity information. In many labs, manual review even precludes deducing minor contributors. Yet sexual assault DNA mixture crimes are critically important to solve.

Computer technology permits the rapid automated interpretation, matching and reporting of DNA profiles from mixture evidence.^{1,2} Such technology provides a new mechanism for forensic scientists to work with computer tools that can help them solve crimes. In particular, a forensic scientist can control the computer to perform different “what if?” scenarios to elicit the most useful genetic identification information from the data.

Cybergenetics TrueAllele® Casework system has two input streams for each case: (1) the user’s selection of which DNA samples (and their laboratory processed STR data) to consider, and (2) the underlying DNA sequencer lane data. Once the user has made their sample selection, the DNA interpretation that infers DNA profiles for each contributor is performed by automated objective statistical computation. If case suspects are available, their profiles are automatically compared against the inferred crime scene profiles to assess match strength.

By controlling the first input stream (the selection of forensically significant DNA samples and data), a scientist can explore different case scenarios. For example:

- a. When initial data are insufficiently informative (e.g., low match strength), the computer result can suggest the need for processing additional DNA samples.
- b. A scientist can interpret the DNA samples from one location at a crime scene, separately interpret the samples from a second location, as well as interpret all the samples at once.
- c. Informative DNA specimens can be further developed in the laboratory to generate more sample data that can be used in computer interpretation.
- d. Low quality STR data (e.g., having low signals or spike artifacts) can be regenerated, using any or all of the data in subsequent computer analyses.
- e. A scientist can separately and jointly analyze serial crime hypotheses, in order to determine the strength of a link between the crime scenes.
- f. Alternative assumptions can be made about the number of mixture contributors.

The TrueAllele® user interface enables this “what if?” scenario analysis by providing the scientist with absolute control over which data are used in the interpretation. The scientist can explore one scenario at a time, or ask the computer to automatically solve many different mixture problems for the case. The user can walk away from the machine while it does its work. As the computer solves each scenario, the results are recorded in a database, and the DNA profile and match results become available for review.

Forensic scientists are highly educated professionals who can solve crimes by thinking “forensically” about evidence. Computers can provide highly sophisticated numerical processing that can rapidly and accurately infer DNA profiles, even from highly complex data. By extending the forensic scientist’s human intuition with access to powerful computational tools, a person can more completely understand the DNA evidence in a case.

References:

¹ Perlin MW. Simple reporting of complex DNA evidence: automated computer interpretation. In: Promega’s Fourteenth International Symposium on Human Identification, Phoenix, AZ, 2003.

² Perlin MW. Real-time DNA investigation. In: Promega’s Sixteenth International Symposium on Human Identification, Dallas, TX, 2005.

DNA, Mixture, Automation

B118 Case Notes and Documentation in the International Program

Sandra J. Wiersema, BS, FBI Laboratory, 2501 Investigation Parkway, Quantico, VA 22135*

After attending this presentation, attendees will be familiar with observations and procedures that should be documented when opening and working a case in the laboratory. These observations should include packaging, condition of packaging, package labels, shipping numbers, condition of seals, bar-code numbers, description of evidence, and condition of evidence.

This presentation will impact the forensic community and/or humanity by enabling to record case notes in such a way that another competent examiner can evaluate the procedures used, the data accumulated, the interpretation of the data, and the conclusions reached.

Case documentation should include notations regarding each procedure conducted, the conditions if applicable, and the results of the procedure. Notes regarding the photography of evidence would include documenting camera settings, film choice, lighting and filter specifications, exposure time, and film development techniques. Notes regarding chemical enhancement would include the specific reagent used, positive and negative controls, development techniques, and observations of results. Notes regarding the preparation of test impressions would include the media used and the method of recording the impressions.

Case notes should be recorded in sufficient detail that another competent examiner can evaluate the procedures used, the data accumulated, the interpretation of the data, and the conclusions reached. For footwear and tire tread evidence, documentation of a size and design association could include a natural size image of the questioned impression with a transparent test impression overlay affixed to the impression. A positive identification could include enlargements of the questioned and known impressions with identifying characteristics indicated. Any elimination could include natural size or enlarged images of the questioned impression and the known shoe with eliminating features indicated.

Although this presentation is specific to footwear and tire impression evidence, the general procedures are applicable to any type of evidence examined in the laboratory.

Several actual cases will be presented using the suggested documentation procedures.

Documentation, Evidence, Footwear

B119 Reporting the Results of Forensic Science Examinations

Joseph P. Bono, MA, United States Secret Service Laboratory, 950 H Street, NW, Washington, DC 20223; Kenneth E. Melson, JD*, United States Attorneys Office, 2100 Jamieson Avenue, Alexandria, VA 22314; John H. Hingson III, JD*, 409 Center Street, Oregon City, OR 97045; and Peter D. Barnett, BS*, Forensic Science Associates, 3053 Research Drive, Richmond, CA 94806*

After attending this presentation, attendees will become familiar with the enhancements in report writing to satisfy the possible future requirements of the judicial system

This presentation will impact the forensic community and/or humanity by demonstrating the process of reporting the results of forensic examinations may be tightened by the judicial system. This presentation is the first step in familiarizing forensic science examiners and attorneys of possible ways to address this issue.

An important facet of any forensic science examination is the report of analysis prepared by the examiner. In many criminal cases, the report will determine, or at least influence, the direction of the case for both the

prosecutor and the defense. The thoroughness of reports has been subject to much debate. From a defense perspective the reports are often incomplete and a subterfuge to sandbag the defendant. ASCLD/LAB has recently revised the standards for contents of laboratory reports. Statements of conclusions or opinions may also be vague or misleading to the non-scientist. From the view of the criminal justice system, these reports are crucial. But what should they contain?

A case record in the laboratory is different from the report of analysis that usually ends up in the hands of the attorneys. Case records consist of both examination documentation and administrative documentation. Currently, the report of analysis that leaves the laboratory can run the spectrum of one word (“Cocaine”) in a drug case to a multi-page report in a DNA or trace evidence case. How much of the case record should be included in the report?

This joint session involving attorneys and criminalists will address the following issues: What is the responsibility of the government laboratory to provide all the information and data as a part of the report of analysis? Is the discovery process sufficient for the defense to obtain information that is not in the report? What standards or controls are in place to ensure that results are reported clearly, unambiguously and objectively? How does the analyst distinguish between an opinion, an interpretation, and a conclusion? Should the examiner define the meaning of terms used in the conclusion or opinion contained in the report? Should the report include a narrative on how a conclusion was derived, or should the conclusion stand on its own? Should all reports from experts on both the prosecution and defense sides be subjected to the same degree of scrutiny and generally accepted standards?

Reporting Requirements, Case Records, Results of Examination

B120 Essential Context and Concerns About the “Context Effect”

Peter R. De Forest, DCrim, John Jay College, City University of New York, 445 West 59th Street, New York, NY 10019; Joseph P. Bono, MA*, United States Secret Service Laboratory, 950 H Street, NW, Washington, DC 20223; John J. Lentini, BA, Applied Technical Services, 1190 Atlanta Industrial Drive, Marietta, GA 30066; and Ronald L. Singer, MS, Tarrant County Medical Examiner’s Office, 200 Feliks Gwozdz Place, Fort Worth, TX 76104-4919*

After attending this presentation, attendees become more aware of the “context effect” and the need to incorporate case context into problem definition while minimizing the chance of bias.

This presentation will impact the forensic community and/or humanity by increasing awareness of the perils of the so-called “context effect” while understanding the need for case context in framing relevant scientific questions for case solutions in criminalistics.

Science is a human endeavor. As such, human failings can corrupt it. Some highly publicized examples of error, malfeasance, and fraud have been seen in many branches of science. Despite these examples, science has been described as self-correcting. It is clearly self-correcting when it is directed to developing knowledge about the universe as the result of the efforts of many individual scientists expended over an extended period of time. This built-in self-correction alone may suffice under such circumstances. However, for dealing with applications of science to shorter-term inquiries, the inherent self-correcting nature of science cannot be relied on exclusively. It needs to be supplemented and augmented by additional correction mechanisms and safeguards. Special attention must be given to these. One concern is investigator bias, which may go unrecognized by an otherwise qualified and well-meaning scientific investigator. The bias may be the result of long-held beliefs or the result of recently acquired information that is peripheral to the scientific inquiry. The fact that the bias may not be recognized by its possessor makes it particularly insidious and difficult to deal with.

Perhaps bias cannot be eliminated from affecting human thought and reasoning, but steps can be taken to try to eliminate its undesirable effects. This is certainly important in criminalistics where the effects of such bias can be particularly pernicious and may affect the life and liberty of others and have a negative impact on the quality of justice.

In criminalistics one potential source of such bias is extra-evidential knowledge of case details or case context and has been called the *context effect*. Some commentators¹ have suggested that forensic scientists or criminalists should work blind – *i.e.*, that they be isolated from knowledge of details of the case. Although such a suggested solution to the problem is well intended, it reveals a misunderstanding concerning the nature of criminalistics and the analysis and interpretation of physical evidence. It assumes that the criminalist is operating as a technician carrying out testing to address simple predefined questions. It avoids the issue as to how the analytical problems to be addressed are defined and circumscribed. The tacit assumption seems to be that this is the role of the non-scientist investigator. Unfortunately, too often this is the way some laboratory systems operate even when consideration has not been given to efforts to address the context effect. The suggestion to combat the context effect by having the scientist work blind can only serve to exacerbate a bad situation where evidence recognition, case solutions, and ultimately justice may suffer from a lack of early scientific involvement. There is a failure to understand that framing questions to be addressed is one of the most challenging and critical aspects of science. Criminalistics is no exception. Scientific problems in criminalistics need to be defined and addressed by scientists. With respect to specific case problems, this requires context knowledge.^{2,3} Thus, the apparent dilemma. How can the effects of possible bias arising from knowledge of context be prevented while at the same time knowledge of context is taken advantage of in informing the questions to be addressed? Putting blinders on the scientist while conducting casework is not the solution. There are alternatives. These need to be strengthened and applied more widely. Several in combination can allow the best of both worlds. All start with scientific leadership and the cultivation of a healthy scientific climate in the laboratory system. In such a laboratory system the role of the scientist in following the scientific method and pursuing scientific truth is made explicit. Here it is made clear that one’s obligation is to the science, not one side or the other in a case. With frequent discussion, this is internalized and becomes a source of pride for the individual scientists. Hypotheses are tested by making strenuous efforts to disprove them. Alternate hypotheses are entertained and given full consideration in this process of hypothesis testing and evaluation. The quality of the scientific work and independence of the scientist is also aided by formalized quality assurance procedures of case review and proficiency testing. These are incorporated in laboratory accreditation and individual certification programs.

In the course of casework for both prosecution and defense the authors have had the opportunity to study and critique the work product of individual scientists and of laboratories in detail. Scientists and laboratories that are able to resist external influences and pressures do exist. They can and must become the norm.

References:

¹ Risinger, D.M., Saks, M.J., Rosenthal, R., and Thompson, W., “The *Daubert/Kumho* Implications of Observer Effects in Forensic Science: Hidden Problems of Expectation and Suggestion,” *University of California Law Review* 90, 2002, pp. 1-56.

² De Forest, P.R., “Recapturing the Essence of Criminalistics”, Founders Lecture, California Association of Criminalists, *Science and Justice*, Vol. 39, July-September, 1999, pp. 196-208.

³ De Forest, P.R., “Crime Scene Investigation”, in *Encyclopedia of Law Enforcement*, L. Sullivan, ed., Sage Publications, Thousand Oaks, CA, 2005, pp. 111-116.

Context Effect, Context in Framing Scientific Questions, Problem Solving

B121 Research Findings on the Ethical Standards in Forensic Science

Robin T. Bowen, MA, West Virginia University, 3040 University Avenue, PO Box 6217, Morgantown, WV 26506-6217*

After attending this presentation, attendees will understand the results of a study concerning the ethical considerations in forensic science conducted at the 2006 American Academy of Forensic Sciences annual meeting. Attendees will learn more about the training requirements, standards, and needs of the forensic science community regarding the subject of ethics. This topic involves the entire forensic science community and is not discipline specific.

This presentation will impact the forensic community and/or humanity by making the forensic community aware of the need for standardized training in ethics for forensic professionals.

The goal of this presentation is to present the forensic community with the ethical challenges faced by those within the profession.

This presentation will communicate the research conducted on ethical considerations that forensic scientists face. Through investigation into the ethics of science, health, business, and research West Virginia University's Forensic Science Initiative has identified which ethical issues are most prevalent in the forensic science community. Important skills gained by studying ethics include improved ethical awareness, knowledge of relevant standards (AAFS, IAI, ASCLD, etc.), skill in ethical decision making, and appropriate ethical actions. Such skills are crucial to maintaining the integrity of the forensic sciences.

The data were collected at the 2006 American Academy of Forensic Sciences meeting in Seattle, WA. A survey was employed to tap into the thoughts and opinions of the forensic science community. The survey presented some common occurrences and asked participants to provide their perspective. The overall response to the survey was excellent, having over 600 surveys completed. The results had a fairly even distribution among disciplines, age groups, and experience levels. The research will be correlated based on the trends shown among age groups. Do the answers provided by young professionals vary greatly from their older mentors? The results provide the answers to such correlative questions as well as give attendees an intriguing look at how colleagues view various situations. In addition, the results identified the profession's position on ethical merit and determined what steps should be taken for future improvement.

The major areas of concern within forensic science include falsification, fabrication, and misuse of resources. Another common concern among many fields, including forensic science, is the misrepresentation of credentials. The issue of misrepresented credentials is prevalent in the presentation of expert testimony. It is shown that people often over look seemingly smaller ethical issues, such as padding resumes and travel expenses. These issues are closely observed to determine the potential impact on the forensic science community.

This research is an excerpt from an online course offered at West Virginia University. Through a grant provided by the National Institute of Justice, the course applies to all forensic professionals. The course covers topics such as the history of ethics, science and research, forensic ethics, unethical behavior, and the future of ethics in criminal investigations. The course is specialized and focuses on forensic science in response to the stated need for formal ethics training.

The data show that many individuals may not realize when a situation contains ethical issues or could be misinterpreted as unethical. This presentation will assist in making some of the grey areas slightly more black or white. The culture of forensic science needs to give more attention to this subject by placing stricter requirements on the training of professionals in ethics and by understanding the consequences for wrongdoing.

Ethics, Standards, Training

B122 Ethics in the Courtroom — A Scientist's Obligations: A Legal Perspective

Christine A. Funk, JD, State of Minnesota Board of Public Defense Trial Team, 919 Vermillion Street, Suite 200, Hastings, MN 55033*

After attending this presentation, attendees will have a better understanding of the workings of prosecutors and defense attorneys, in conjunction with judges as cases are handled. This course will offer practical, legally and scientifically based solutions to common ethical problems the scientist may face.

This presentation will impact the forensic community and/or humanity by providing scientists with a foundation within which to work when ethical situations arise in a courtroom setting.

If you've been a scientist for more than five minutes, you know that the public (and most lawyers) don't understand what you do, how you do it, or that there are limitations to science. The recent wave of Crime Lab related shows have impressed upon the public a fabulous range of scientific techniques – including many that don't actually exist.

Just as most science doesn't really play out as it does on TV, most legal proceedings don't either. The way casework is actually handled in court is nothing like what you see on TV. Attorneys are bound by Rules of Criminal Procedure, Rules of Discovery, Brady, and its progeny. Attorney's roles are spelled out in Rules of Professional Responsibility and Board of Judicial Standards. Understanding these roles and rules may help the scientist understand where they fit in the process.

When a scientist is faced with an ethical dilemma involving one or more of the members of the criminal justice system, do you know what to do? Who do you talk to? Should you talk to anyone? Do you know who your lawyer is? Do you know if you have a lawyer? When a scientist is asked to conceal, keep quiet about, or misrepresent science, what steps can and should you take?

Knowing what really goes on in the courtroom - and more importantly, in the judge's chambers and in conference rooms before court - may help the scientist better understand how to handle ethical conflicts.

Relying on case law, Rules of Criminal Procedure, and ethical mandates from the scientific and legal communities, this course will examine what a scientist can do, should do, or must do in a given situation. It will provide scientists with a broader understanding of the role attorneys play in the legal process, and the ethical standards to which attorneys are bound.

Ethics, Scientists, Lawyers

B123 Using the Quality Assurance Standards for Forensic DNA Testing Laboratories to Distinguish the Unqualified Forensic DNA Experts From the Qualified Forensic DNA Experts

George J. Schiro, Jr., MS, Acadiana Criminalistics Laboratory, 5004 West Admiral Doyle Drive, New Iberia, LA 70560*

After attending this presentation, attendees will have learned how to distinguish unqualified forensic DNA experts from qualified forensic DNA experts by using the information in the "Quality Assurance Standards for Forensic DNA Testing Laboratories" and the Quality Assurance Audit Document for Forensic DNA and Convicted Offender DNA Databasing Laboratories.

This presentation will impact the forensic community and/or humanity by reducing the number of unqualified individuals who represent themselves as forensic DNA analysts in court.

The evolution of quality assurance standards for forensic DNA testing laboratories began in 1988 with the formation of the Technical Working Group on DNA Analysis Methods (TWGDAM). TWGDAM set about the daunting task of standardizing DNA technology among crime labs so that common controls and practices could be established. This standardization would allow crime labs to databank DNA data so that this information could then be shared by all crime labs. These efforts have resulted in the highly successful Combined DNA Index System (CODIS) database.

TWGDAM first published a set of guidelines on a quality assurance program for DNA analysis in 1991. This was followed by Congressional passage of the DNA Identification Act of 1994. This act established a panel of public and private sector experts in DNA analysis, law, and ethics. This panel, known as the DNA Advisory Board (DAB), was to evaluate current DNA quality practices. Using the TWGDAM guidelines as a starting point, the DAB established DNA quality assurance standards that replaced the TWGDAM guidelines. The DNA quality assurance standards must be met in order for public crime labs to receive federal funding and to participate in the National DNA Index System (NDIS). Private forensic DNA testing labs must also meet these standards to work outsourced samples from the public crime labs. In essence, the quality assurance standards have become the “industry standards” for DNA analysis.

In order to demonstrate compliance with the standards, forensic DNA laboratories must undergo an audit by an external agency at least once every two years. To meet this end and to standardize the audits for consistency, the FBI, with input from the Scientific Working Group on DNA Analytical Methods (SWGAM – formerly known as TWGDAM), developed a standardized audit document known as the “Quality Assurance Audit for Forensic DNA and Convicted Offender DNA Databasing Laboratories.” While some critics have denigrated these standards as being “minimal,” this audit document is 50 pages in length and contains over 200 standards and sub-standards with which forensic DNA analytical labs must comply.

While effective as an audit document, the Quality Assurance Audit for Forensic DNA and Convicted Offender DNA Databasing Laboratories also provides information that can be used in court by attorneys to help the judge decide if a proclaimed forensic DNA analytical expert is qualified to testify as an expert witness. Using this document as a starting point, the author has developed 68 questions and 27 discovery requests covering the areas of a DNA quality assurance program, lab organization and management, personnel qualifications, lab facilities, evidence control, validation studies, analytical procedures, equipment calibration and maintenance, reports, case review, proficiency testing, corrective actions, previous audits, lab safety, and subcontracting labs. Answers to these questions and responses to these discovery requests will indicate if the self-proclaimed forensic DNA expert and his or her lab can meet the standards that most public and private forensic DNA analysts and their labs routinely meet.

Quality, Standards, DNA

B124 Cross-Examination: Is It an Adequate Remedy for Incompetent or Dishonest Expert Testimony? — Personal Reflections

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After attending this presentation, attendees will consider the difficulties in dealing with incompetent or dishonest expert testimony.

This presentation will impact the forensic community and/or humanity by pointing out the dangers and problems of dealing with improper expert testimony.

Traditionally, cross-examination has been regarded as the remedy to protect against an inaccurate or dishonest witness. It evolved for this purpose with lay witnesses. Even after the advent and gradual increase in the frequency of occurrence of expert testimony, the reliance on cross-examination for utilization with experts appears to have continued seamlessly with little demonstrable thought being given to its appropriateness and effectiveness with expert witnesses. It seems to be an article of faith on the part of many lawyers and judges that cross-examination is an effective remedy for use with incompetent or dishonest experts. In general, based on 45 years of observations, which are admittedly anecdotal rather than scientific, the author finds that untested belief in the efficacy of cross-examination of such experts to be illusory.

Incompetent or dishonest experts who have been qualified as experts numerous times by scientifically naïve judges are unlikely to be excluded as expert witnesses by the next court they encounter. Once one is deemed “court qualified” it seems that one has earned a lifetime pass. Those who are incompetent but have survived multiple appearances as expert witnesses and are still sought by counsel are unlikely to be discredited on the basis of an additional cross-examination. The process of bootstrapping can continue for many years. Most attorneys, no matter how much trial experience they have, do not know enough science, let alone forensic science, to be effective with such an expert. Although it may not guarantee that the dishonest or incompetent “expert” will be discredited, the assistance of an experienced criminalist can be of great help. The criminalist can prepare ideas for cross-examination questions well in advance of the anticipated expert testimony. These ideas should then be discussed with the attorney doing the cross-examination to assure that the purpose of each question idea is understood before it is transformed by the attorney into the series of questions to be asked. The discussion should include anticipated answers. This is necessary so that questions capable of probing to several levels of depth will be available. On rare occasions the consulting criminalist may sit at counsel table to provide more immediate assistance. This may have certain drawbacks and needs to be a very carefully considered tactical decision made by the attorney.

In addition to cross-examination, additional protection against incompetent “experts” may be gained through a *voir dire* on qualifications. Again the assistance of a criminalist should be utilized. Unfortunately, exposing an experienced but incompetent expert is not as easy as it should be. Here and with the cross-examination itself, having the finder of fact understand the subtleties of the appropriateness or inappropriateness of the qualifications of the “expert” for giving the opinions proffered is essential, but often difficult to accomplish. In short, attorneys should not be overconfident about being able to prevent incompetent experts from testifying or relying on an unassisted cross-examination to discredit them when they do. Help should be sought.

Without identifying cases or experts, the authors will illustrate the thesis with case examples. This area is in need of more study and research. Traditional beliefs and blind faith are no substitute for knowledge.

Cross-Examination, Expert Testimony, Ethics

B125 XRF Results From the Rapid Analysis of Crime Scene Evidence as a Real-Time Investigative Aid

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The goal of this presentation is to serve as an update on the progress made in establishing a portable X-Ray fluorescence (XRF) unit for the non-destructive characterization of evidence at crime scenes.

Much as DNA testing and databases revolutionized how forensic science impacted criminal investigations in the last decade, this presentation will impact the forensic community and/or humanity by demonstrating how rapid characterization of crime scene evidence has the potential to do this – and more – for the next decade.

Unintended consequences of enhanced analytical power (sensitivity and selectivity) include increased sophistication of forensic science methods and longer, more complicated analysis. While these analyses ultimately lead to more probative information, the information is not available to the investigator at the scene during the critical first stages of a case. Unlike common television depictions, the results of most forensic analyses often are not available for months, rendering them virtually useless to the investigation. Right after an incident, suspects are “off balance” and have not had sufficient time to evaluate their circumstances. The ability to refute specific claims scientifically would give investigators the necessary leverage during interrogation.

Over the past 8 years, significant progress has been made to address this. A unique partnership developed between NASA’s Goddard Space Flight Center, forensic scientists, law enforcement personnel, academicians, and prosecuting attorneys to adapt space exploration technology developed by Goddard to problems encountered at the crime scene. The concept of civilians who can benefit from technology developed for space exploration is not a new one. The notion of “dual use” began under President Reagan, and has continued as a key strategic focal area for NASA ever since. As a result of this partnership, a small, portable X-Ray fluorescence (XRF) unit has been developed. XRF as a forensic tool in general, and in alpha and beta tests performed by the team, has been applied in multiple laboratory settings to characterize various forms of trace evidence.

Much as DNA testing and databases revolutionized how forensic science impacted criminal investigations in the last decade, rapid characterization of crime scene evidence has the potential to do this – and more – for the next decade. As the investigative power of DNA testing and DNA database searching is fully realized, significant efforts by others are underway to extend this DNA technology to crime scene applications. A portable XRF unit will serve as one of the tools that will allow investigators to extend this potential enhancement of investigative timeliness to not just biological evidence, but all of the evidence found at crime scenes. This will allow scene personnel to focus investigative efforts on those areas and items at the scene that are most likely to yield probative information needed, and resolve violent crimes as quickly as possible. This lowers recidivism rates both in theory and in every conceivable practical sense.

Beta testing of the portable XRF prototype has demonstrated the ability to characterize various forms of physical evidence. Advanced spectral analysis software allows complex spectra to be analyzed quickly. Through the application of special NASA expertise, software such as PENELOPE allows forward Monte Carlo modeling of spectra

for materials that could be encountered at scenes, but might not occur in existing XRF databases.

The unique XRF instrument has been designed with a rugged, adjustable voltage, X-Ray generator. A virtually mass-less sample support combined with an effectively designed beam catcher have resulted in drastic reduction of background from coherent scattering. The use of a Shottky Cadmium/Telluride detector allows for higher efficiencies for detecting the more energetic photons.

The design of an affordable and effective method of real-time elemental analysis has the potential to revolutionize the information retrieved from crime scenes and increase the information available to investigators before they even leave the crime scene. This presentation will provide a short history of the portable XRF program, specific findings related to the application of XRF to various types of trace residues commonly encountered during violent crime investigations, and a summary of potential strategies underway for commercialization of this analytical tool by the Federal government agencies involved.

Elemental Analysis, Crime Scene, Trace Evidence

B126 Get More From Your Crime Scene Process

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After attending this presentation, attendees will have learned business concepts for improving methods of crime scene and evidence processing as well as understand the application of two new tools to integrate the crime scene and laboratory processing of evidence.

This presentation will impact the forensic community and/or humanity by demonstrating how new technologies can be implemented to integrate the crime scene process of recognition, collection, and protection of evidence with the laboratory processing of evidence to minimize errors and improve effectiveness and efficiency.

There is compelling evidence that the relationship between the crime scene evidence team and laboratory personnel needs to be redesigned or even re-established to provide the best possible product to the criminal justice community. While the science of forensics continues to advance, the process of collecting evidence at crime scenes has remained remarkably unchanged for more than a century. As DNA analysis and other forensic techniques gain increasing importance in today’s crime investigations and court cases—in some situations making the difference between life and death for a crime suspect—it is critically important that evidence collection moves into the modern era through the utilization of new technologies.

The following tools help ensure this industry continues to provide America’s criminal justice system with high-quality forensic services in a timely manner:

- ISO/IEC 17025: 2005 accreditation standard
- Business concepts for quality management
- New evidence collection tools

This presentation will focus on the use of new technologies designed to simplify the documentation and collection of evidence at crime scenes. Documentation of information taken at the crime scene has not changed very much over time because many investigators still prefer the old-fashioned pen and paper approach of taking notes despite the wide availability of computers or other electronic devices designed for that purpose. Although computers greatly improve the quality and accuracy of crime scene reports, and make it easier to store and access the information, the use of these technologies requires a significant cultural shift that has not yet found wide acceptance. A new device that provides all the benefits of a computer, but still only requires a pen and paper will be described and results from a comparison study will be reported.

The more often evidence is handled, the greater the risk it will become contaminated or be otherwise compromised. With DNA processing becoming even more sensitive, contamination becomes an even greater concern. Additionally, as the sheer number of swab samples taken at crime scenes continues to skyrocket, investigators are seeking more effective ways of packaging and labeling this important evidence to minimize risk.

A new collection device designed to minimize handling, improve packaging and labeling as well as simplify the processing of evidence collected at crime scenes will also be described and results of a comparison study will be reported.

Advances in technology are improving the efficiency and effectiveness of processing crime scenes and the collected evidence. Recently developed tools help to integrate and improve the quality of the collection and processing of evidence. This allows for the processing of more cases without having to increase resources.

Process, Collection, Documentation

B127 Optimized Analysis of Triacetone Triperoxide by GC-MS

Michael E. Sigman, PhD, and Douglas Clark, BA, BS, University of Central Florida, National Center for Forensic Science, PO Box 162367, Orlando, FL 32816-2367*

After attending this presentation, attendees will have learned about an improved method for the detection of TATP via GC/MS.

This presentation will impact the forensic community and/or humanity by demonstrating the development of an optimized and improved method for the detection of the peroxide explosive TATP by GC/MS using both electron Impact and Chemical Ionization.

This presentation will focus on the analysis of triacetone triperoxide by gas chromatography-mass spectrometry and optimization of the method to give sub-nanogram detection limits. This presentation will impact society and forensic science by providing new analytical guidelines for the analysis of an explosive which is easily prepared from commercially available materials and is often used by terrorists. The explosive triacetone triperoxide (TATP) has been analyzed by gas chromatography – mass spectrometry (GC-MS) using both electron ionization and chemical ionization to give sub-nanogram detection limits. Ammonia and methane were used as chemical ionization reagent gases. Analysis by positive ion chemical ionization (PICI) with ammonia as the reagent gas gave sub-nanogram levels of detection, while PICI analysis with methane as the reagent gas gave detection limits in the low nanogram range. Analysis by negative ion chemical ionization (NICI) also gave low nanogram detection levels with both methane and ammonia reagent gases. Low detection limits were achieved by optimizing both gas chromatography and mass spectrometry operating parameters. Specifically, lower injector port, GC oven, and MS source temperatures were found to strongly favor trace detection of TATP. Analyses of neat TATP solutions in acetonitrile were carried out on linear quadrupole and quadrupole ion trap instruments. GC-MS analyses of TATP vapor was also performed by sampling the headspace over solid TATP samples at various temperatures. Both SPME and syringe sampling techniques were utilized. Analysis of TATP by PICI GC-MS using ammonia reagent gas is the preferred analytical method, producing lower limits of detection as well as an intense m/z 240 diagnostic adduct ion corresponding to $[\text{TATP} + \text{NH}_4]^+$ (base peak for the quadrupole, and greater than 60% of base peak for the ion trap). Isolation of $[\text{TATP} + \text{NH}_4]^+$ in the ion trap mass spectrometer with subsequent collision induced dissociation (CID) produced weak daughter ions in the 60 – 240 m/z range (m/z 168, 132, & 115). No CID product ion mass was observed at m/z 223 ($[\text{TATP} + \text{H}]^+$), which would correspond to the loss of ammonia from the diagnostic adduct ion at m/z

240 ($[\text{TATP} + \text{NH}_4]^+$). Density functional theory calculations at the B88LYP/DVZP level gave a TATP- NH_4^+ binding energy of 25 kcal/mol, which is 11 kcal/mol lower than the peroxide bond energy (36.5 kcal/mol). This result suggests that the $[\text{TATP} + \text{NH}_4]^+$ ion may dissociate under CID, rather than fragmenting the TATP moiety. The calculations also showed an energy difference between $[\text{TATP} + \text{NH}_4]^+$ and $[\text{TATP} + \text{H}]^+ + \text{NH}_3$ to be 23 kcal/mol and the structure of the $[\text{TATP} + \text{H}]^+$ ion had an excessively long C-O bond (2.605 Å). This result suggests CID of the $[\text{TATP} + \text{NH}_4]^+$ ion could proceed with a loss of NH_3 and subsequent TATP bond rupture and further fragmentation. CID results are in agreement with the calculations which suggest dissociation of the complex to form NH_4^+ and TATP at energies lower than peroxide bond dissociation in the mass spectrometer. The results of experiments provide a method for pico-gram detection levels of TATP using commercial instrumentation commonly available in forensic laboratories.

Mass Spectrometry, Explosives, TATP

B128 Discrimination of C-4 Plastic Explosives by GC/MS Analysis of Impurities Associated With the Manufacturing Process of RDX

Michael E. Sigman, PhD, Katie L. Steele, BS, and Charles D. Clark, BA, National Center for Forensic Science at the University of Central Florida, PO Box 162367, Orlando, FL 32816-2367*

After attending this presentation, attendees will understand a method that allows for discrimination of different C-4 plastic explosive samples by examining the relative amounts of selected impurities that are associated with the manufacturing process of RDX, the main component in C-4.

This presentation will impact the forensic community and/or humanity by providing improved explosives analysis and sourcing methods.

RDX is the basis for many military explosives worldwide. It is currently the most important military high explosive in the United States, and the second most widely used explosive by the U.S. military behind TNT. Rarely used alone, RDX is a common component in plastic explosives, detonators, high explosives in artillery rounds, Claymore mines, and demolition kits. RDX can be synthesized by several different processes; however, two methods have commonly been used for mass production; the Woolwich process and the Bachmann process. The first involves direct nitrolysis of hexamine, yielding between 70-75% RDX and trace amounts of HMX. In the latter process, hexamine is reacted with an ammonium nitrate and nitric acid mixture at 75°C with acetic acid and acetic anhydride. This process produces about 79 percent RDX initially with 6-8% HMX, and trace amounts of 1,3,5-Triazine (TAX), 1,3,5,7-Tetrazocine (SEX), and other impurities. These differences in product/by-product compositions can serve as a basis for discrimination between C-4 samples.

C-4 is a putty-like explosive mixture made up of finely powdered RDX and plasticizers having similar malleability to that of modeling clay. C-4 has prevailed as the popular composition of plastic explosives by the United States military, and is comprised of RDX (91%), Plasticizer (5.30%), Polyisobutylene (2.10%), and Motor oil (1.60%). In work done by Reardon and Bender, composition of oil components were examined to discriminate between C-4 samples.¹

In this study, RDX was extracted in triplicate from several different C-4 samples following a modified version of the extraction procedures published by Keto.² The extracts were then analyzed by GC/MS, using negative chemical ionization (NCI) and selective ion monitoring (SIM) to detect RDX and associated impurities. The ratios of impurities to RDX were calculated. Ratios were also calculated from LC mass

spectral data collected by negative ion electrospray ionization (ESI). The samples were directly injected and infused with a 0.1 mM solution of sodium chloride to promote the formation of chlorine adducts.³ An Analysis of Variance followed by a Tukey Honstely Significant Difference (HSD) Post-test was performed on the pair-wise C-4 comparisons from.

References:

¹ Reardon MR, Bender EC. Differentiation of Composition C-4 Based on the Analysis of the Process Oil. *J. Forensic Sci* 2005;50(3):564-70.

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C-4, GC/MS, Explosives

B129 Stable Isotopes of Explosives Provide Useful Forensic Information

James Ehleringer, PhD, and Michael Lott, BS, IsoForensics Inc., 423 Wakara Way, Suite 205, Salt Lake City, UT 84108*

After attending this presentation, attendees will understand how the utility of stable isotope analyses adds additional useful information with respect to explosives investigations.

This presentation will impact the forensic community and/or humanity by providing information and case examples of a new and useful technique for the forensic science investigative community.

There are differences in the natural abundances of carbon, nitrogen, and oxygen isotopes in high explosives (HMX, RDX, PETN, and TNT) that make it possible to establish the relatedness of two or more explosive samples of identical chemical composition. In some cases there are sufficient differences in the isotope ratio composition of explosive compounds produced by different manufacturers that allow identification of the manufacturer or manufacturing process. The stable isotope ratio composition of explosive residues are closely related to that of the undetonated materials. The forensic application of stable isotope ratios in explosives is discussed through its application to a specific criminal case.

Explosives, Stable Isotopes, Terrorism

B130 New SPME Coatings for Explosives Detection by Ion Mobility Spectrometry (IMS)

Patricia Guerra, BS, and José R. Almirall, PhD, Florida International University, 11200 SW 8th Street, CP 194, Miami, FL 33199*

After attending this presentation, attendees will have learned about improved sampling and pre-concentration of increased capacity Solid Phase MicroExtraction (SPME) coatings and configurations for the detection of explosives, their taggants, and chemical markers by Ion Mobility Spectrometry.

This presentation will impact the forensic community and/or humanity by demonstrating improved sampling and pre-concentration of increased capacity SPME coatings and configurations for the detection of explosives, their taggants, and chemical markers by IMS.

Solid Phase MicroExtraction (SPME) is an effective sampling method which combines extraction and pre-concentration in one step and can be useful towards the detection and presumptive identification

of trace level explosives. The use of SPME for explosives detection is advantageous since it is a solvent-free extraction method where virtually no sample preparation is required which saves time and reduces the use of harmful chemicals. Ambient conditions are suitable for SPME extractions making the method convenient for routine field analyses. SPME is not exhaustive, but is rather an equilibrium technique which allows for the concentration of analyte in the sample matrix to be correlated to the amount extracted. Forensic examiners will find SPME useful since it is a fast, clean, selective, and semi-quantitative method which can be made field-portable.

Recently, SPME has been successfully coupled to an ion mobility spectrometer (IMS)¹. This interface combines both the extraction efficiency of SPME and the detection capabilities of IMS and is easily adaptable to the approximately 10,000 instruments currently in use which are conducting over 10 million analyses each year². Moreover, this interface allows vapor sampling in addition to particle sampling, which has implications for increased sensitivity and affords the option for the extraction of taggants and odor signatures of explosives rather than the parent compounds themselves. The geometry of SPME in this interface is a fiber made of fused silica or a metal coated with a polymeric coating or a sorbent phase, but it is proposed that by coating disk-shaped substrates via dip-coating and/or spin-coating, the surface area and capacity of the extraction phase can be increased. This allows for more samples to be extracted thus increasing sensitivity. Additionally, it is conjectured that by increasing the surface area and capacity of the extraction phase, larger areas such as rooms, cargo holders, or outside areas can be sampled. These coated disks are similar conceptually to the stir-bar SPME configuration, but they will be amenable to a second-generation SPME-IMS thermal desorber. Polydimethyl siloxane (PDMS) has been found to be the most effective and most rugged polymeric phase at extracting explosives with the minimum carry-over of commercially available fibers, and will be the starting point for this evaluation of SPME phases for explosives extraction³.

The aims of this work include improving the probability of detecting explosives in the field by increasing the surface area and altering the chemistry of SPME for improved selectivity and extraction of explosives. The extracted explosives are subsequently desorbed into an IMS for field analysis. Vapor sampling is conducted for various taggants present in explosives such as 2-nitrotoluene (2-NT), 4-nitrotoluene (4-NT), and 2,3-dimethyl-2,3-dinitrobutane (DMNB), and odor signatures, also known as chemical markers that emanate from explosives such as 2,4-DNT, 2,6-DNT, 1,3-DE-1,3-DPU, 2-ethylhexanol, R(+)-limonene, DPA, cyclohexanone, and 2-NPA. These have been identified as some of the volatile and semi-volatile compounds that canines alert to when detecting explosives⁴. The extraction of explosives, their taggants and odor signatures, are improved by the SPME coatings tested and this novel SPME geometry is coupled to IMS for detection.

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³ N Lorenzo, TL Wan, RJ Harper, YL Hsu, M Chow, S Rose, KG Furton; Laboratory and Field Experiments Used to Identify *Canis Lupus var. Familiaris* Active OdorSignature Chemicals from Drugs, Explosives, and Humans. *Journal of Analytical and Bioanalytical Chemistry* 376 (2003) 1212 – 1224.

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SPME, IMS, Explosives

B131 Target Compound Analysis for the Individualization of Gasolines

J. Graham Rankin, PhD, and Megan Fletcher, BA, Marshall University, Forensic Science Program, 1401 Forensic Science Drive, Huntington, WV 25701*

After attending this presentation, attendees will learn about the importance of creating a collection of gasolines and understand how target response data is used to analyze the gasoline profiles.

This presentation will impact the forensic community and/or humanity by giving forensic chemists a new way of analyzing for the presence of gasoline using target response data and peak area ratios between different components in a sample to be able to compare it to a known sample.

Gas chromatography-mass spectrometry was used to analyze gasoline samples procured from multiple states over 4-year period. The collection has over 200 samples from twenty-four different states. The majority of samples came from West Virginia and the surrounding areas. Samples included gasolines from octane ratings of 87, 89, 93, 100 and 112 (leaded specialty gasolines), E-85, and gasohols (87 and 93 octane).

The samples were prepared by using a neat injection onto the column. Although much of the gas chromatography-mass spectroscopy method was based on research by Dolan, temperature ramping was changed to achieve better separation of later eluting compounds.¹ The data analysis was based upon target response data and the component ratios of thirty-seven target compounds.

Gasoline is the most common accelerant used in arson cases, as well as many domestic and international terrorist bombings using fire bombs. Fire bombs are easy and inexpensive to construct, but can cause significant destruction. However, they also have the potential to leave unburned gasoline on the "thrower" and even in the bottle. Creating this collection of gasoline profiles is useful in determining the presence of gasoline at the scene of a suspect fire or bombing and then connecting it to its source.

Twenty-two different component ratios were analyzed that spanned thirty-seven components of gasoline, including methyl-tert-butyl-ether (MTBE) and ethanol. The peak areas were analyzed and percent relative standard deviations calculated based upon the component ratios to determine if the GC-MS method and quantification method were reproducible with multiple injections. After analyzing the target ions and new retention times for each of the components with the help of compound standards, better results were achieved; meaning, the results from multiple injections were much more consistent.

These peak ratios are also important in distinguishing gasoline from pyrolysis products produced in a fire according to Lentini.² That makes gasoline one of the most common misdiagnosed accelerants. It was, therefore, important to make sure that the ratios used in this study were correct and the results reproducible.

Further research performed in this study included looking for the presence of MTBE and ethanol, as well as differences in octanes, including E-85. MTBE and ethanol are oxygenates that help to reduce engine "knocking" and are better for the environment as they help to reduce engine emissions by replacing unburned hydrocarbons and carbon monoxide with oxygen. It was found that MTBE was present in many early samples, specifically in larger cities and along the east coast. Later samples showed a decrease in the use of MTBE, probably from recent findings of ground leaks and its identity as a possible carcinogen in the drinking water.³ Results from gasohols were investigated to determine if ethanol was present in samples that claimed it on the gasoline pump and if it was present in samples where it was not claimed.

The findings from this research show promise creating profiles of gasolines using the peak ratios with reproducible results. The potential for comparing the samples of evaporated gasoline with the same unevaporated gasoline should also be investigated using the shorter temperature ramping and new target ion responses for compounds.

References:

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Gasoline Analysis, Fire Debris, Target Compound Analysis

B132 Individualization of Gasoline by Gas Chromatography/Mass Spectrometry and Covariance Mapping

Mary R. Williams, BS, Michael E. Sigman, PhD, and Rebecca G. Ivy, BS, University of Central Florida, National Center for Forensic Science, PO Box 162367, Orlando, FL 32816-2367*

After attending this presentation, attendees will learn results from a study on the use of a covariance mapping method to discriminate between fresh gasoline samples collected from a single geographical area.

This presentation will impact the forensic community and/or humanity by demonstrating an approach to discrimination of non-biological physical evidence samples at a known statistical certainty of Type I errors, while controlling the probability of a Type II error at less than 1%.

Ten gasoline samples from various gas stations in the Orlando Florida area were collected and analyzed in triplicate by gas chromatography/mass spectrometry. The analyses followed the ASTM E 1618-01 standard test method for the identification of ignitable liquid residues from fire debris samples. A covariance mapping technique combined with a t-test statistic was utilized to differentiate the gasoline samples from one another. A covariance matrix for each sample was calculated from the retention time-ion abundance data obtained from the gas chromatography-mass spectrometry data. Distance metrics were calculated between the covariance matrices of the same-sample replicate analyses (30 analyses) and the different-sample analyses (405 analyses). The same-sample and different-sample analyses were shown to comprise two distinct populations with significantly different average distances and standard deviations. The significance of the differences between the populations was determined based on a statistical t-test. A power analysis was performed to determine the number of analyses required to discriminate between two samples while maintaining a probability of a Type II error (β) occurring below 1%. Based on the power analysis results, the triplicate analyses of two samples was shown to be sufficient to discriminate the samples using a t-test while keeping β less than 0.01 at a significance level, α of 0.05. Analysis of the 45 possible pair-wise comparisons between the gasoline samples found that 100% of the samples were statistically distinguishable from one another with no Type II errors occurring. Blind tests were conducted with two of the 10 gasoline samples presented as unknowns. The two unknowns were compared against the 10 known samples of gasoline using the distance metric. One of the unknowns was found to be undistinguishable from the corresponding sample from the original set (i.e. the unknown was correctly identified). In the other case, the unknown was found to differ from the original sample constituting a type I error. The results of these tests offer a new way for forensic scientists to discriminate between unaltered gasoline samples, those which are not evaporated, degraded by microorganisms or contain interfering products from fire debris. The statistics for the test offer known error rates, which are controlled by the experimental design. The results demonstrate a statistically acceptable method of physical evidence comparison in forensic science.

Covariance Mapping, Gasoline, Gas Chromatography/Mass Spectrometry

B133 Laboratory Gunshot Residue Contamination Study: Part II

Jason L. Schroeder, BS, James L. Jackson, BS, Roger Kahn, PhD, Ashraf Mozayani, PhD, and Luis A. Sanchez, MD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will become familiar with the persistent nature of gunshot residue (GSR) particles, the potential for contamination of GSR particles, and the need to monitor the environment in which GSR analysis is conducted. Additionally, the results of a thorough trace evidence laboratory GSR contamination study will be presented.

This presentation will impact the forensic community and/or humanity by confirming the applicability of GSR analysis as a viable analytical tool that serves a criminal investigation, identifying the nature of GSR contamination, and establishing quality control and quality assurance procedures necessary to produce accurate and reliable results.

The continued objective of this study is to identify all potential areas of contamination in a high volume forensic laboratory environment and to further monitor and improve the effectiveness of quality control procedures currently practiced.

The use of gunshot residue analysis by scanning electron microscopy (SEM) as a forensic analytical tool is under scrutiny. Some critics assert that GSR testing is unreliable, subject to contamination. These studies indicate the transfer of GSR particles is not a frequent event and that individuals who have not been in contact with a firearm or ammunition will not be expected to have GSR on their hands.

The authors previously reported (Laboratory Gunshot Residue Contamination Study, AAFS 2006, Seattle Washington) that they were unable to find GSR contamination in the laboratory, that the hands of analysts performing these analyses were free of contamination, and both evidence technician's and law enforcement officers' hands performing duties throughout the laboratory were free of contamination. Characteristic GSR particles on exterior surfaces such as elevator buttons and exterior doors were identified. These results identified the need for continued monitoring of the trace laboratory and additional areas such as common areas.

In the present study, laboratory break rooms, office areas, rest room fixtures, and evidence rooms were also tested. The on-site Harris County Sheriff's Office Firearms Laboratory and immediate vicinity, located on a separate floor from the GSR testing area, were also tested. Within the GSR area, additional tests were done on analyst's hands and various laboratory surfaces as well as the room air. Stubs studied for contamination were handled as evidence stubs with all applicable QA/QC procedures in place. Trace analyst's hands were stubbed to accompany each GSR analysis performed. All other areas of interest were randomly stubbed without prior notice.

No particles indicative of GSR were identified in the immediate vicinity of the trace laboratory and the extended environment. As expected, GSR particles were easily recovered from the Harris County Sheriff's Office Firearms Laboratory.

In summary, the second phase of this study further confirmed that the environment of the HCMEO laboratory was free of the presence of GSR, that the QA/QC procedures being followed by the evidence section further minimized the concern, and that the HCMEO Trace Evidence Laboratory performs analyses in an environment free of contamination.

Gunshot Residue (GSR), Contamination, Scanning Electron Microscopy (SEM)

B134 Chemical Analysis of Gunshot Residues on Typical Mortal Wounds

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The goal of this research was to detect the typical and fatal wounds caused by firearms projectiles.

This presentation will impact the forensic community and/or humanity by confirming whether or not wounds were caused by firearm projectiles. If so, the firing distance can also be calculated by analysis of many chemical compounds found on entrance wounds as well as exit wounds as well as holes in the clothes.

Firing a firearm produces combustion of primer and gunpowder in the cartridges. The residue of the combustion product, unburned primer, or powder components can be used to detect the firing status. The residue may be found on the skin of a body or clothing of the victim or target of firing, on an entrance wound, or other target materials at the scene. The discharge of a firearm can deposit residues on a person in close proximity.

The major primer elements are lead (Pb), Barium (Ba), or Antimony (Sb). Usually all three are present less common elements include aluminium (Al), Sulphur (S), Tin (Sn), Calcium (Ca), Potassium (K), Chlorine (Cl) and Silicon (Si). In addition, primer residue may adhere to fired bullets or projectiles and gradually ablate through the path of the projectiles. Thus primer residue may be found in target or entrance wounds and/or exit wounds.

The cartridge case, bullet, bullet coating, and metal-jacketed bullet also contain specific elements that can be detected by the process of chemical analysis. Virtually all cartridge cases are made of brass (70% copper and 30% zinc) although a few have a nickel coating. Primer cases are also made of similar composition. Bullet cores are most often made of alloys of lead and antimony. Bullet jackets are usually made of brass (90% copper and 10% zinc) and alloys of copper and nickel.

Modern gunpowder, known as smokeless powder, can contain up to 23 organic compounds. Nitrocellulose is virtually always present along with other compounds containing nitrate or nitrogen. Modern gunpowder is also described as 'single-base' when the basic ingredient is Nitrocellulose and 'double-base' when 1 to 40% nitroglycerine is added.

In the physical examination of the target for gunshot residues it may be remembered that lead residues may be found up to 30 ft from the muzzle and always present on the opposite side of penetrated target. Though the amount of residue deposited tends to decrease with increasing range of fire, the actual deposits can be highly variable for a range up to 20 cm.

On using the above process of chemical analysis gunshot residues were detected on typical mortal wounds, those responsible for firing on the target, the direction of firing, and position of firing, etc. Cases containing wounds and holes in clothing were confirmed whether or not the wounds or holes were caused by firearm projectiles.

Wounds, Analysis, Holes

B135 Persistence of Gunshot Residue (GSR) in Decomposing Tissue Samples

Luther S. Schaeffer, BS, and Ruth J.H. Waddell, PhD, MSU School of Criminal Justice, Department of Forensic Chemistry, 506 Baker Hall, East Lansing, MI 48824*

After attending this presentation, attendees will understand the problems associated with detecting gunshot residue (GSR) in decomposed tissue samples.

This presentation will impact the forensic community and/or humanity by detailing appropriate tissue sample collection methods and storage procedures, as well as sample preparation and instrumental analysis procedures. The cost-effectiveness, and feasibility and applicability of scanning electron microscopy energy dispersive X-Ray detection (SEM/EDX) and inductively coupled plasma-mass spectrometry (ICPMS) for the detection of GSR in tissue samples will be discussed.

In a badly decomposed body, cause of death by gunshot wound may be difficult to discern since the wound itself and any tattooing around the wound are not visible and may be misidentified. In the absence of any other pertinent evidence, this can make cause of death determinations difficult for the forensic pathologist. The objective of this research is to develop and optimize instrumental methods for the detection of GSR in decomposed tissues samples, which ultimately could be used to aid forensic pathologists in their cause of death determinations.

Ten gunshots were fired into a euthanized pig carcass using a 9 mm Glock pistol and 115 grain, full metal-jacketed cartridges. The gun and cartridges were chosen to accurately represent commonly recovered equipment from gun-related criminal cases. Shots were fired by a veteran firearms specialist from a local police department at a distance of 5 cm muzzle to target, which allowed visible tattooing but no cross-contamination between wounds. The gun was cleaned thoroughly between shots fired. The carcass was subsequently placed out in a field, along with a control carcass into which no shots were fired. Both carcasses were covered in screened cages to prevent interference by predators while still exposing the carcasses to the elements. Over the following seven days, wounds were excised from one carcass and suitable controls were collected from the second. The tissue samples were wrapped in wax paper and stored at -80° C until analysis.

Presently, there are numerous publications detailing the detection and collection of GSR using techniques such as flame atomic absorption spectrometry, differential pulse anodic stripping voltammetry, X-Ray microfluorescence, SEM/EDX, and many chemical reagent color tests. However, these studies typically detect GSR from cloth, hand swabs, or dried skin samples; a very limited selection of literature describes experiments in which GSR is collected and analyzed from decomposed tissue samples. Most tests analyze samples for evidence which is described as characteristic of GSR, this is typically a specific elemental analysis monitoring levels of Pb, Sb, and Ba. The tests are determined positive or negative compared to levels of Pb, Sb, and Ba detected from that of a control sample.

In this study light microscopy was used to observe tattooing of the skin prior to further instrumental analysis. GSR morphology, elemental composition and its persistence was determined through SEM/EDX, which is a commonly accepted method of GSR analysis with concurrent determination by ICPMS which is a sensitive technique capable of analyzing samples with complex matrices. Optimization of sampling technique, analysis procedure, as well as instrumental parameters for both analytical methods were performed during the course of this study.

The data presented herein serves to supplement the development of novel techniques for difficult, time-consuming analyses.

GSR, ICPMS, SEM/EDX

B136 A Method for the Analysis of Thermally Labile Components of Smokeless Gunpowder by Gas Chromatography/Mass Spectrometry

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After attending this presentation, attendees will learn how thermally labile compounds found in smokeless gunpowder can be easily detected and identified without the additional cost of a PVT inlet.

This presentation will impact the forensic community and/or humanity by providing a convenient alternative to purchasing a PVT inlet for specific GC applications.

Typical Gas Chromatograph (GC) injection port temperatures can be as high as 250°C to completely volatilize some dissolved components of smokeless gunpowder. This is not desirable because at high temperatures some components become unstable, degrade, and can affect other compounds. This method allows for a lower inlet operating temperature and uses an instrument control macro to elevate the inlet and oven temperatures to purge the GC system prior to the subsequent sample injection. The increased temperature volatilizes components that are retained in the inlet at the lower operating temperature.

Agilent gas chromatographs are controlled by commands that are either sent to the instrument automatically, such as in a GC method, or by commands that can be input manually by the operator. The operator can either use the graphical user interface to enter commands, or the command line that is accessible at the bottom of the Chemstation window. The commands offered by the graphical user interface are limited and do not allow the invocation of all commands in the Chemstation environment. The macro in this method relies upon the use of the commands "IFTI" and "OVTI", which control the injection port temperature and oven temperature respectively. By inserting the macro into the "instrument control macro" section in the GC method, commands are invoked that raise the inlet and oven temperature to 250°C and 290°C respectively and holds the temperature for a designated period of time. Then, both parameters are returned to normal operating temperature before the next sample injection.

While there are other options available for the analysis of thermally labile compounds such as capillary electrophoresis (CE) or High Performance Liquid Chromatography (HPLC), this method permits the analysis with little additional expense or equipment. The only disadvantage is the increase in sample run time due to the passive dissipation of heat from the inlet after the macro has run.

As a result, thermally labile compounds such as nitroglycerine (NG), diphenylamine (DPA), ethyl centralite (EC), methyl centralite (MC), dinitrotoluene (DNT), dibutylphthalate (DBP), and others can be easily detected and identified, which can assist in the discrimination between physically similar smokeless gunpowder.

Thermally Labile, Inlet, Smokeless Gunpowder

B137 Identification of Smokeless Powders Through Capillary Electrophoresis Using Highly Sulfated Beta Cyclodextrin

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The goal of this presentation is to determine the usefulness of highly sulfated beta cyclodextrin (HS- β -CD) in capillary electrophoresis (CE) for smokeless powder discrimination. This particular additive has been used for CE-MS analysis with electrospray mass spectrometry¹.

This presentation will impact the forensic community by demonstrating how HS- β -CD can be used as a pseudostationary phase in CE to separate and identify different components in smokeless powders and eventually discriminate between powders pre- and post-blast.

Smokeless powder evidence is frequently used in forensic casework to associate post-blast or gunpowder residue to a particular brand of powder. Such identification can eventually lead to potential suppliers who could be interrogated for further insight on past purchases and possible identification of a suspect. Samples were prepared by placing 1.0 mg of each powder into 1.0 mL of methyl chloride and extracting overnight. The supernatant is then air dried to remove the methyl chloride. Buffer is then added to the sample and mixed thoroughly. After which, the mixture is injected onto a CE instrument equipped with photodiode array detection for the separation and identification of the individual components. This information can then be used to help determine the manufacturer of the powder.

All standards and samples were analyzed using Beckman-Coulter P/ACE MDQ capillary electrophoresis system. Each run entailed a 2 minute 0.1M sodium hydroxide flush, followed by a 2-minute wash with the buffer being used. Initial testing was conducted with SDS in a borate buffer to provide plausible data for comparison.² Then a series of low pH buffers with varying concentrations of HS- β -CD, were examined to test the efficacy of the reagent. The varying concentrations were examined to develop a more time-efficient procedure. The initial buffer used was 50 mM phosphate and 10mM HS- β -CD at a pH of 2.5 which had proven to be an optimal concentration for separating amphetamines.³ Further optimization was then performed to improve run time, increase resolution, and enhance compatibility with electrospray mass spectrometry.

The separation efficiency of cyclodextrin is based on its use as a pseudostationary phase in the CE buffer. The circular shape of the molecule includes a hydrophobic and optically active interior that forms inclusion complexes with host molecules. Considering that many components of smokeless powders are neutral, negatively charged sulfated cyclodextrins permit separations based on differential migration within the applied electric field. Following development of the buffer, samples of unburned and burned smokeless powders were compared to a standard mixture of common compounds found in known powders, including ethyl centralite, 2-nitrotoluene, 4-nitrotoluene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, nitroglycerine, 2-nitrodiphenylamine, 4-nitrodiphenylamine, diphenylamine, dimethyl phthalate, and diethyl phthalate. The results demonstrated an efficient and reproducible separation of powder components.

Overall, the use of HS- β -CD in CE represents an attractive alternative to micellar mobile phases incorporating SDS. Future analysis through the incorporation of capillary electrophoresis coupled to electrospray mass spectroscopy will permit direct identification of each component in the powder.

References:

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Capillary Electrophoresis, Cyclodextrin, Smokeless Powders

B138 Comparison of HPLC and MECE for the Analysis of Organic Constituents in Smokeless Powder

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After attending this presentation, attendees will come to appreciate the need for proper method validation for the quantitative analysis of the organic components of smokeless powders, as well as any limitations of these methods in regards to accuracy and precision.

This presentation will impact the forensic community and/or humanity by providing a better understanding of what knowledge can be gained from conducting validation studies on methodology used in the quantitative analysis of the organic components of smokeless powders.

Micellar electrokinetic capillary electrophoresis (MECE) and reverse phase high performance liquid chromatography (RP-HPLC) have both been shown to be viable analytical methods for the qualitative identification of the organic components found in smokeless powders which are used in arms ammunition and improvised explosive devices. The identification of these organic components from evidence collected at the scene of a crime can aid in the subsequent criminal investigation. Still, for these methods to be of greatest use to the forensic scientist, they must also yield reliable quantitative results for smokeless powder additives. MacCrehan et al (2002) have conducted an interlaboratory study, which compared the measurements of two powders, 1928-1 (the black particles of HiSkor 700X by the IMR Powder Company) and 1928-2 (231 distributed by Winchester). 1928-1 was shown to contain the propellant nitroglycerin (NG) and the stabilizer ethyl centralite (EC), while 1928-2 was shown to contain NG, the stabilizer diphenylamine (DPA) and DPA's nitrated derivative N-nitrosodiphenylamine (NnDPA). This study, however, yielded some inconsistencies in the quantitative identifications made by the participating laboratories. MacCrehan et al (2004) report the need for, and the introduction of, a reference material (RM 8107) for low explosives by the National Institute of Standards and Technology (NIST). This reference material contains NG, EC, DPA, and NnDPA. Quantitative determinations of RM 8107's components were carried out by NIST using both MECE and liquid chromatography. This reference material provides analytical laboratories with a means to validate their methods of organic additives analysis.

The purpose of the present research was to evaluate the performances of MECE and RP-HPLC in the quantitative identification of the additives present in the three powders mentioned above. Satisfactory performances in the analysis of these three materials will permit, and optimize, further research involving the characterization of smokeless powders in this laboratory. The goal of this ongoing project is to develop a database of analytical values for common organic constituents of smokeless powder in order to establish statistical criteria for determining the similarity between two different samples obtained in forensic evidence (i.e., bomb scene and suspect). At present the common procedure is comparison of physical size and shape of powder grains to determine brand (Wallace and Midkiff, 1993). Lot to lot variation within brand in chemical composition may provide additional probative value to the evidence.

Nitroglycerin measurements made by MECE analysis were found to fall within the expected ranges (MacCrehan et al, 2002) for 1928-1 and 1928-2. DPA and EC measurements for these powders were below the reported values. All measurements of additives present in RM 8107 were found to be consistent with NIST values. Intra-day reproducibility ranged from 1.83 to 2.08 (%RSD) for NG measurements made by MECE, while inter-day reproducibility was found to be 3.60 NG and 14.60 for DPA over a five day period. MECE provided resolutions

around 3.548 for the closely eluting 2,4 DNT and 2,6 DNT. The capillary efficiency as determined by NG was ~60,300 theoretical plates. RP-HPLC analyses were below the reported range of values for all additives of all powders. Repeatability of NG was observed to be from 2.88 to 5.15 (%RSD) of the three powders within a day, while inter day reproducibility was found to be 1.02 for NG and 2.50 for DPA, over a five day period. RP-HPLC was unable to completely resolve 2,4 DNT and 2,6 DNT (resolution of 0.808) and displayed an efficiency of ~9,200 theoretical plates for NG.

Smokeless Powder, HPLC, Capillary Electrophoresis

B139 Determination of Capsaicin on Suspect's Garment Exposed to Aerosol Pepper Sprays

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The goal of this study is to determine the capsaicin from suspect's garment, exposed to aerosol pepper sprays in riot control and investigate the effects of time and environmental conditions on aerosol pepper spray residues on fabric samples for the confirmation of the suspect stains and contribution to justice in future forensic casework.

This presentation will impact the forensic community and/or humanity by focusing on the obtained data to determine whether it can be useful for the confirmation of invisible suspect stains and so contribute to justice in future forensic caseworks.

Background: Aerosol pepper sprays "Oleoresin Capsicum (OC)" are used as a self-defense and as a weapon in riot control. Oleoresin Capsicum became available as an aerosol spray and was initially used by FBI personnel in 1973. The residue of Oleoresin Capsicum may be found on a person's garment in forensic cases. Aerosol pepper spray causes an intense burning sensation, lacrimation, temporary blindness, erythema, restricted breathing, and disorientation. Aerosol pepper sprays are supplied in hand-held pressurized canisters, which include a diluted solution of the concentrated extracts of cayenne pepper plant. This study aimed to determine the capsaicin from the suspect's garment exposed to aerosol pepper sprays in riot control and investigate the effects of time and environmental conditions on aerosol pepper spray residues on fabric samples.

Experimental Method: Analysis of capsaicin was performed with GC/EI-MS (Gas Chromatography/Electron Impact-mass spectrometry using an HP (Hewlett-Packard) 6890 equipped with a 5973 mass selective detector. This method has been developed in the current study to evaluate the extraction and quantitative analysis of capsaicin from four different fabrics (cotton, synthetic, cotton-synthetic, wool) after homogenous pepper spray treatment. Fabrics were dried and stored at ambient room conditions. Every fabric was divided into seven equal parts on 0, 1, 2, 5, 10, 20, and 30th days. Three pieces (30x30 mm; approximately 66-250 mg) were cut each day. The fabrics were placed into 13x100 mm test tubes. As described in a previous research, the best recovery for capsaicin is provided with methanol extraction. Five milliliters of methanol were added to the test tube and sonicated for 10 minutes. The fabrics were removed from test tubes. The extracts were dried under a stream of nitrogen at room temperature. To each test tube, 100 µl of N,N-diphenylethylenediamine solution in methanol as internal standard and 100 µl of methanol were added.

Conclusions: In this study the capsaicin from victim's garment exposed to aerosol pepper spray in riot control or self-defense was determined and the effect of time to aerosol pepper spray on fabric samples was investigated. During the method development process, methanol provided good recovery (approximately 82%) for capsaicin on different fabrics. Limit of detection for capsaicin was 40 g/L.

Calibration curves for the methanol extracts of capsaicin were linear from 40-500 g/L (ppm). Capsaicin may be investigated from the garment of a suspect due to its non-volatile character. This study showed that capsaicin amounts on fabrics in 30 days changed about 20% according to effects of time and ambient room conditions. After 3 months of storage in ambient room conditions, the concentration of capsaicin was reduced. The data obtained by this study can be useful for the confirmation of invisible suspect stains during at least three months and thus contribute to justice in future forensic casework. This method can be used simply for analysis of capsaicin from suspect's garments exposed to aerosol pepper sprays and it is suitable for application in forensic routine analysis.

Capsaicin, Riot Control, Marker

B140 Validation of Computer-Assisted Classification of Trace Evidence Data: Lies, Damned Lies, and Multivariate Statistics

Stephen L. Morgan, PhD, Department of Chemistry & Biochemistry, University of South Carolina, Columbia, SC 29208; and Edward G. Bartick, PhD, FBI Laboratory, Counterterrorism & Forensic Science Research Unit, FBI Academy, Quantico, VA 22135*

After attending this presentation, attendees will gain a basic understanding of multivariate statistical methods such as principal component analysis and linear discriminant analysis; the application of these techniques to the discrimination of forensic data; an understanding of when to use (and not use) these methods; issues in the validation of computer-assisted data analysis applied to forensic problems.

This presentation will impact the forensic community and/or humanity by increasing understanding of the potential benefits and misuses of multivariate statistics in the interpretation of trace evidence.

Identification of patterns in analytical chemical data and interpretation of observed differences is a frequent task for forensic chemists. A fiber examiner might perform UV/visible microspectrophotometry on known and questioned fibers to evaluate possible associations between source and location. An arson investigator might compare headspace gas chromatograms taken from questioned debris at the scene of a suspicious fire with chromatograms of known accelerants. Most forensic scientists are familiar with statistics associated with a single type of measurement variable, for example, the refractive index of questioned glass fragments might be measured for a comparison with known window glass fragments from a crime scene. The resulting set of sample data values have only one variable (refractive index) measured for a number of different objects (different glass fragments). Statistics for summarizing such *univariate* measurements, including the sample mean and the sample standard deviation, and hypothesis testing, such as the two-sample *t*-test for means, is commonly used. However, spectroscopic, chromatographic, or mass spectrometric instruments routinely produce megabytes of data of high dimensionality from a single analytical run on a single forensic sample. Scientists are less familiar with *multivariate* statistics based on measurements of two or more variables for each sample. Real differences in multivariate data might not show up as the presence or absence of a single peak, or as inflation or reduction of single peaks. A *combination* of small changes could be the key to recognizing a significant difference. Trace evidence found at a crime scene may also involve mixtures of several chemical components. How should the similarity of complex patterns be evaluated? Are the patterns similar enough to be considered to have originated from similar source materials? Can differences be explained simply by sampling variability from the original source or by experimental variability in the laboratory? How can outliers be recognized? Increases in computing power have

made computationally intensive data analysis feasible, and the increased availability of software for multivariate statistics has made these techniques accessible.

The scope of this presentation includes the techniques of principal component analysis (PCA) and linear discriminant analysis (LDA). Examples of forensic applications will include arson investigation, analysis of polymer trace evidence, and forensic fiber examination. PCA and LDA can be employed as exploratory tools to detect and to visualize patterns and as predictive tools to classify and discriminate among data from different analytical samples. The statistical significance of differences and similarities can be assessed, and the reliability of discrimination among groups of samples can be evaluated using multivariate statistics. A summary of practical guidelines for use and interpretation will be presented along with examples of misuse and steps that should be taken to validate such computer assisted data analysis.

Trace Evidence, Statistics, Validation

B141 Polarized Infrared Spectroscopy of Tapes as a Supplement to Physical Matching

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After attending this presentation, attendees will gain knowledge of alternative and supplemental techniques for examination of tape evidence.

This presentation will impact the forensic community and/or humanity by demonstrating how the use of polarized microscopy techniques can be applied to the infrared region and tape evidence.

The goal of this study was to examine the value of polarized infrared (IR) microscopy as a supplement to visual examination and physical matching for tapes. Tapes generally consist of adhesive coated on a polymeric support material. The polymer has an ordered, pseudocrystalline structure amenable to analysis with polarized microscopy. Such studies are not limited to the visual range. Here, studies were conducted in the visual and infrared regions using normal and polarized light and the results were correlated with photomicrographs of the torn tape edges.

Samples were prepared by placing torn Scotch® tape, matching end to end, on a microscope slide. Images were collected under normal and crossed polars in the visual range. Using instrumental software, a grid was established on the polymer side of the torn tape on both of the separated pieces at various distances from the tear edge. Infrared spectra were obtained at each spot for a total of ten per grid. The mapping was repeated under crossed infrared polars. The only accessory to the IR microscope was a motorized stage; a standard detector was used. Each mapping run required less than an hour.

Results clearly showed effects of damage to the polymer tape support material that could be correlated with distance from the torn edges. In regions of the tear, complete disruption of the pseudo-crystalline polymeric structure was evident in the infrared spectrum obtained under crossed-polars. Selected peaks in the spectrum were identified as markers of structural damage and signs of such damage were evident in the infrared spectra before the damage was visually identifiable. Patterns were also noted across tears. Results of this study could be used to supplement physical matching of tape and would be particularly useful in cases where tape edges are so badly damaged that visual matching methods are problematical.

Tape Evidence, Infrared Microscopy, Polarized Light Microscopy

B142 Multiplex PCR Detection of Three Class A Bioterrorism Agents for Use in a Miniature Ceramic PCR Device

Jason R. Besecker, BS, Korey Moeller, BS, Ken Cornell, PhD, and Greg Hampikian, PhD, Boise State University, 1910 University Drive, Boise, ID 83725*

After attending this presentation, attendees will be informed on the subject of biological warfare agents, and current research on the development of a multiplex PCR assay for the detection of three Class A select agents. This presentation will also discuss the development of a miniaturized PCR device constructed from novel materials for the use as a biosensor.

This presentation will impact the forensic community and/or humanity by demonstrating introducing a new PCR detection system that is capable of specifically amplifying three select agents with high sensitivity.

Throughout history biological organisms have been used for the purpose of warfare. It is known that some countries, such as Iraq and the former Soviet Union, have developed weaponized forms of biological warfare agents (BWA's) that have the potential to kill more people than nuclear or chemical attacks. It is estimated that ten grams of weaponized anthrax spores could result in the deaths of as many people as an attack using a ton of the nerve agent sarin.

Protecting the United States from biowarfare and bioterrorism requires detectors capable of identifying a collection of agents that might be used in a biological attack; methods currently used to identify the release of BWA's are inadequate. The goal of this project is to develop a multiplex PCR system capable of specifically and selectively amplifying target regions of three select bioterrorism agents. The developed multiplex assay is to be used in a PCR device constructed of a novel material, low temperature co-fired ceramic (LTCC). This device is being developed at Boise State University as collaboration between this laboratory (G.H.) and Dr. Amy Moll's laboratory in the College of Engineering.

Select agents chosen for use in the multiplex assay are *Bacillus anthracis*, *Francisella tularensis*, and *Yersinia pestis*; all of which are Category A select agents on the CDC's list of bioterrorism agents. Both high sensitivity and specificity are required of the multiplex PCR system to reduce the risk of false negative and false positive results. Primer sets for two different genes in each organism were selected to improve sensitivity and reliability of the assay. The majority of the selected gene targets are located on plasmids. Since plasmids generally occur in higher copy number than chromosomal DNA, sensitivity of the assay will be improved. Most of the chosen gene targets are virulence factors, which will help the assay discriminate pathogenic strains from non-virulent close relatives.

PCR primers used in the assay, which have previously been tested to specifically amplify regions of these species' DNA, were chosen from the literature. Working with Category A select agents requires a biosafety level 3 facility. Boise State University is biosafety level 2, so working with the actual organisms is not possible. To bypass this obstacle, DNA from non-virulent or attenuated strains of the bacteria were initially used in PCR reactions to obtain amplicons. Subsequently, the amplicons were ligated into plasmids then transformed into competent *E. coli* cells for replication. Plasmids were extracted from the *E. coli* and concentration of extracted plasmid DNA was determined using a spectrophotometer. Ten fold serial dilutions were performed on the plasmids until one plasmid copy is present in one μ l. These plasmid dilutions were used to initially optimize conditions for the multiplex PCR and test sensitivity of the assay to establish a detection limit for each individual primer pair. Specificity of the multiplex assay has been tested by performing PCR reactions on samples containing the recombinant plasmids and a myriad of microbial contaminants,

including closely related species. Also, serial diluted plasmid DNA was tested in contaminated samples to determine if background bacteria interfere with the detection limit of the assay. When all conditions for the multiplex assay were optimized using the recombinant plasmids, the attenuated strains of the organisms were tested in the multiplex assay. Tests for specificity and sensitivity were carried out in the same manner as in the plasmid assays. After the multiplex assay has been optimized, and tested for sensitivity and specificity using attenuated strains of the organisms, PCR reactions will be tested in a device that is constructed of LTCC using samples of the actual class A select agents.

Bioterrorism, PCR, Detection

B143 Development of a Microbial Forensics Real-Time PCR Assay for the Detection of *Coxiella Burnetii*

Kristin D. Hill-Williams, BA, Virginia Commonwealth University, Forensic Science Department, 1000 West Cary Street, Richmond, VA 23284; and Amy Chiefari, BA, Maureen Shail, BS, Christina Egan, PhD, and Nick M. Cirino, PhD, New York State Department of Health, Wadsworth Center, 120 New Scotland Avenue, Albany, NY 12208*

After attending this presentation, attendees will have a basic understanding of *Coxiella burnetii* as it is used as a bioterrorism agent, how a real-time PCR assay for this bacterium is developed, and the positive impact that faster detection methods, such as real-time PCR, have on the microbial forensics community.

This presentation will impact the forensic community and/or humanity by providing knowledge about real-time PCR assay development for the detection of biothreat agents.

Coxiella burnetii, the causative agent of Q fever, is a gram negative, coccobacillus bacterium primarily found in cattle, goats, sheep, and other herd animals. Human contraction of this bacterium occurs from breathing aerosols containing amniotic fluid or fecal matter from herd animals. This pathogen is relatively resistant to heat, drying, and many common disinfectants. *C. burnetii* is on the list of select agents as determined by the Department of Health and Human Services and the United States Department of Agriculture because it is highly infectious and could be easily disseminated in aerosol form over a large area. Clinical symptomology of Q fever infection are similar to that of the flu including high fever, headache, muscle and joint pain, and coughing. Standard detection methods such as cell culture and antibody-based detection can be time consuming and labor intensive. The development of a rapid screening method is critical to ensure timely and accurate detection in a bioweapon event. Real-time Polymerase Chain Reaction (rtPCR) can be used as a quick and sensitive diagnostic tool and offers many advantages to standard detection methods.

The objective of this study was to design a sensitive and specific rtPCR assay for the detection of *C. burnetii* from clinical and environmental samples. The highly selective isocitrate dehydrogenase (*icd*) gene was chosen for the detection of *C. burnetii*. A comparison of 19 published *C. burnetii* strains was used to generate a consensus sequence to identify regions of similarity in the *icd* gene. PrimerExpress™ software was used to design a TaqMan® rtPCR primer and probe set, and the specificity of the assay design was verified using BLAST software. The FRET probe contained a 5'-reporter dye Cy5™ coupled with a 3'-Black Hole Quencher and the identified oligonucleotides primers were obtained from Integrated DNA Technologies (IDT; Coralville, IA).

This assay was found to be highly sensitive and specific for *C. burnetii*. An assay limit of detection of six gene copies/μL was determined from serial dilutions of recombinant *C. burnetii* target DNA. The efficiency of this assay was calculated to be approximately 100%.

Assay specificity was evaluated against a panel of pathogens including: genetically similar organisms, organisms that cause similar illness, common clinical and environmental microbes, and other select agent organisms. A specific rtPCR assay for *C. burnetii* would decrease the turn around time required for laboratory confirmation of suspected bioterrorism events and facilitate the proper treatment of exposed individuals. The primer and probe set will eventually be incorporated into a rtPCR multiplex being developed at the Biodefense Laboratory at Wadsworth Center (Albany, NY) for the detection of 13 different biothreat agents.

Microbial Forensics, Real-Time PCR, *Coxiella Burnetii*

B144 A Comparative Study of the ABI PRISM® 7500 to the ABI PRISM® 7500 Fast Real-Time PCR Platforms for the Detection of Biothreat Agents

Kristin D. Hill-Williams, BA, Virginia Commonwealth University, Forensic Science Department, 1000 West Cary Street, Richmond, VA 23284; and Amy Chiefari, BA, Maureen Shail, BS, Christina Egan, PhD, and Nick M. Cirino, PhD, New York State Department of Health, Wadsworth Center, 120 New Scotland Avenue, Albany, NY 12208*

After attending this presentation, attendees will have a better understanding of how faster detection methods can aid in forensic investigations of bioterrorism.

This presentation will impact the forensic community and/or humanity by providing knowledge about two real-time PCR platforms that can be used to detect biothreat agents in clinical or environmental samples.

Bioterrorism involves the deliberate release of microorganisms or toxins derived from living organisms that cause illness or death in people, animals, or plants. Biological weapons have been used for centuries from the Assyrians poisoning the well water of their enemies with rye ergot to the Tartar army throwing plague ridden bodies over the walls of their adversaries. Today, with increased knowledge and technology, biological weapons pose a more serious threat than ever before. These weapons are inexpensive to manufacture, relatively easy to prepare and disseminate, and rapidly spread throughout a population. Biothreat agents are able to harm or kill many people in a short amount of time and can cause illnesses that are not recognized right away, delaying correct treatment and isolation of infected individuals. Because of these concerns, it is important to have rapid, sensitive, and robust methods of detection. Currently, a large number of detection methods are available to investigators including but not limited to viable organism culture, mass spectrometry, nucleic acid amplification/detection (e.g., PCR), enzyme-linked immunosorbent assays, and suspension array technologies. Culture methods have been considered the gold standard for microbial identification for many years but it can be time consuming and is generally low throughput, making it unfavorable to use in a bioterrorism event. Real-time PCR (rtPCR) offers many advantages for detection, including high throughput, short assay time, low contamination risk, small genomic sample volume, excellent sensitivity and specificity, and potential to be multiplexed.

The objective of this study is to compare the Applied Biosystems (ABI, Foster City, CA) PRISM® 7500 rtPCR system to the ABI PRISM® 7500 Fast rtPCR system to show that the upgraded fast-block platform works as well with current validated protocols as the ABI PRISM® 7500 rt-PCR system. The TaqMan® rtPCR assay used for comparison in this study was a Wadsworth Biodefense multiplex assay for the detection of ricin toxin, *Fraxisella tularensis*, *Yersinia pestis*, and *Brucella* species. In this study, the LightCycler® FastStart DNA Master HybProbe hot start reaction mix (Roche Applied Science, Indianapolis,

IN) was used because this master mix was shown in previous studies to perform better than the ABI master mix when inhibitors were present in clinical or environmental samples.

The ABI PRISM® 7500 Fast rtPCR platform is similar to the 7500 platform; both support a 96-well plate format and have a five color detection system. The heating block in the ABI PRISM® 7500 Fast instrument has been modified, allowing it to heat and cool more rapidly than the ABI PRISM® 7500 model. The results of this study show that the multiplex assay run times were reduced from 100 minutes on the ABI PRISM® 7500 rtPCR platform to 45 minutes on the ABI PRISM® 7500 Fast rtPCR platform without losing sensitivity. In the advent of a bioterrorism attack, the use of a faster rtPCR system would increase the number of samples screened for potential biothreat agents thus decreasing the amount of time it would take health officials to administer the correct treatment to those exposed or infected.

Microbial Forensics, Real-Time PCR, Bioterrorism

B145 Comparison of Modern Techniques for Amylase Screening

Jarrah R. Myers, MSFS*, and William K. Adkins, MSFS*, Miami-Dade Police Department, Crime Laboratory Bureau, 9105 NW 25th Street, Miami, FL 33172

After attending this presentation, attendees will better understand the current available methods for presumptive amylase screening including a comparison of the ease of use, sample consumption, interpretation of each method. Maybe this presentation can help a laboratory decide which method to validate, especially if resources are limited.

Literature has somewhat detailed the average amount of alpha-amylase in human saliva, though variable, but is lacking the same type of sensitivity/limit of detection levels that are available for semen and blood presumptive screening tests. This presentation will impact the forensic community and/or humanity by demonstrating the side by side sensitivity of Phadebas, starch-iodine and SaliGae® through the use of a human alpha-amylase standard from Sigma for comparative value while also incorporating additional issues like ease of interpretation, sample consumption and cost.

Amylase is a component found in relatively high concentrations in human saliva, and is therefore used as the basis of body fluid screening for the possible presence of saliva in casework samples.

The current available methods for the screening of amylase in a forensic application are growing in number, but not necessarily in popularity. The analyst must often decide whether a prescreening method would be worth the consumption of sample that could be applied for DNA analysis methods. Other obstacles in presumptive amylase testing include the difficulties in interpreting the color change based tests, sensitivity and specificity of the method as well as the high level of variability not only between people, but within each person.

Validation of the SaliGae® presumptive test for saliva encompassed not only the validation of the SaliGae® method including sensitivity and specificity - but also a side by side comparison to two other widely used amylase presumptive tests used in forensic serology: Phadebas and starch-iodine tests. An addition to the study will be a direct determination of a limit of detection for each test in terms of units of activity based on the purchase of a human alpha-amylase standard from Sigma instead of the normal 1:10 or 1:100 sensitivity level made from dilutions of an unknown amount of amylase present in a saliva sample.

In summation, the study plans to evaluate and compare the ease of utility, sample consumption, casework application, interpretational issues as well as cost effectiveness of the each of the above methods for amylase screening.

SaliGae, Presumptive, Amylase

B146 A Capillary Electrophoresis Immunoassay for Forensic Identification of Human Blood

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The goal of this presentation is to introduce a multicolor capillary electrophoretic immunoassay for identification and species testing of suspected blood stains.

This presentation will impact the forensic community and/or humanity by demonstrating how the immunoassay represents an alternative to the Ouchterlony double immunodiffusion method for identification and species testing of bloodstains. This method significantly reduces sample volume, analysis time, and improves assay sensitivity compared to the conventional method.

For admittance into court proceedings, forensic scientists routinely identify a suspected bloodstain as blood of human origin before proceeding to DNA analysis. Conventionally, this is performed via double immunodiffusion (also known as the *Ouchterlony method*) in which both the antibody to adult human hemoglobin (or, antisera for only species testing) and antigen (suspected human blood) diffuse in an agarose gel. Agglutination occurs at an equivalence zone resulting in a precipitated band representing the antigen-antibody complex.¹ This technique is often multiplexed such that the antigen is placed in a single central well and anti-sera of various species are placed in surrounding wells to confirm the species of origin. The advantage of this technique, when using anti-human hemoglobin compared to historical methods, is the combination of blood identification with determination of species of origin in a single test.² However, the disadvantages of this technique are many, including: assessment of precipitin bands is subjective, analysis times are lengthy, and interpretation of cross-reactivity is difficult. Consequently, a capillary electrophoresis immunoassay (CE-IA) has been developed that incorporates the positive attributes of the immunodiffusion assay but circumvents the drawbacks of the conventional technique.

The work presented here focuses on improving species-specific identification of human blood by replacing the double immunodiffusion assay with a capillary electrophoresis-based immunoassay. This non-competitive immunoassay utilizes multiple antibodies to hemoglobin to assess species of origin. Fluorescent tags are used to identify each species uniquely, from which a decrease in free, labeled antibody indicates complexation with the analyte. This assay can be performed in less than 10 minutes and has limits of detection of 1 nM, which significantly improves both the speed and sensitivity compared to the *Ouchterlony method*.

The approach exploited here utilized a non-competitive CE-IA for detection of human hemoglobin (Hb) via laser-induced fluorescence detection. In this assay, a fluorescently-tagged antibody against human Hb (Ab*) is detected as a single peak, while addition of antigen (adult human Hb) reduces the peak area of the Ab* peak. An internal standard, fluorescein, is included with the sample to account for any variability in injection volume. The presence of hemoglobin is determined and the amount quantified by comparing the Ab* peak area before and after addition of Hb. Cross-reactivity of Ab* was assessed by examining the change in peak area after incubation with mouse, rat, pig, and dog blood. Two Ab* were tested for minimal cross-reactivity to hemoglobin from other species.

As in the *Ouchterlony method*, the developed immunoassay tests reactivity of the sample to hemoglobin from other species. In this manner, a multi-color CE-IA was developed where antibodies against each species are tagged with spectrally-resolvable dyes. The cross-

reactivity of a suspected blood-stain can then be assessed for species-of-origin determination.

The multi-color capillary electrophoresis-based immunoassay presented improves the speed and sensitivity of the identification of suspected bloodstains in comparison to the conventional methods. While outside of the scope of this work, it is anticipated that this method will be easily translated to microdevice technology for potential rapid crime scene testing in the near future.

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Immunoassay, Capillary Electrophoresis, Ouchterlony Method

B147 Detection of Semen and Saliva With a Maximum Intensity UV Detection System (Lumatec Superlite 400)

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After attending this presentation, attendees will learn of systematic variation of variables that might affect detection of biological stains on fabric – use of red goggles additional to orange ones – use of UV light possible in daylight if high power machine.

This presentation will impact the forensic community and/or humanity by demonstrating possible change of procedures due to good results in daylight – use of UV lamp at all types of crimes scene, including in daylight.

Introduction: The quality and quantity of detected semen and saliva stains on different types of fabric were tested using a newly developed UV detection system (Lumatec Superlite 400). The system is characterized by a very high output intensity of light so that detection of biological stains even in daylight becomes possible. The machine provides 10 filter positions from 320 to 700 nm with color spectra of white, UVA and blue, violet, turquoise, green, and green-yellow. White (> 400 nm), orange (> 550 nm), and red (>590 nm) goggles were used together with these filters.

Material and Methods: Tested fabric types were 100% polyester — 100% polyamide — 100% cotton — 95% cotton, 5% elastane — 73% cotton, 24% polyamide, 3% elastane — 80% nylon, 20% elastane. As many colors and color combinations of fabric as possible were used, including white and black fabric. 5 and 3 weeks before the analysis, the fabric was stained with either biological stains (saliva, semen) or no stains (control). The clothing was then stored openly in a room under constant conditions (17°C). Some samples were washed at 30°C with “full” detergent (contains oxygen-based bleach), or “soft” detergent (free of bleach). All tests were carried out under blind conditions (observers did not know if a stain was present or not), and either in a dark room, or under constantly illuminated conditions in a regular training room with mostly daylight and some daylight-type artificial light. Biological stains were fresh human and boar semen, and fresh human saliva.

Quantitative Results: (a) Fluorescence intensity was similar in samples that were stored 3 or 5 weeks. (b) After washing, only 25% of the fabric samples with biological stains still produced a detectable fluorescence signal. This was independent of the type of the washing detergent (both “full” and “soft” washing powder led to a 75% reduction of detected samples). (c) To examine differences in the fluorescence of human semen and saliva, the unwashed cloth were compared in 80 combinations of wave length, filters and goggles (10 different filters in the lamp, 3 types of goggles, 5 extra filters (hand-held). Semen and saliva could be detected in 36% (semen) and 41% (saliva) of the combinations, resulting in nearly equal detection rates. (d) Additionally boar and human semen was compared. Even though the amount of pig semen per ejaculation is at least one hundred times increased against men, the fluorescence signal of pig semen is clearly weaker than that of human semen. (e) To check the influence of the color of the fabric on the fluorescence signal, the clothing was grouped into three groups: “bright,” (white, bright blue, pink), “medium” (blue, red, green, orange, yellow) and “dark.” Stains on “medium” and “bright” color types of fabric could be detected in 34%-38% of the cases with a very low rate of weak signals (“medium” fabric colors: 32% intensive detection signal, 2% weak detection signal; “bright” fabric colors: 31% intensive, 3% weak). The detection rate on “dark” fabric (black, brown, dark blue) was nearly the same (38%) but a higher rate (15%) produced only a weak signal. Thus, dark colors, especially pure black, reduce the chance of detection of biological traces, even when using a high-power UV source.

Further Observations: (a) Comparison of two cotton samples in three “medium” and “dark” colors (one jeans skirt (blue) and one black and white top) showed that semen on black cotton could be visualized with the 400-700 nm filter with all goggles, whilst the same filter did not work with bright colors. This contrasts the daily experience as well as other test results. (b) Samples under day/room light conditions with filter wavelengths of 320-500 nm showed only in one third of the cases a weaker fluorescence signal than in darkness. In most cases, the signal was as strong as in darkness. Therefore, the Superlite 400 can be used in the laboratory as well as at crime scenes. (c) Using red goggles designed for ninhydrin applications might be a promising addition to the use of orange goggles for biological stains. At wavelengths between 320 and 570 nm — especially at 550 nm — the red goggles allowed detection of fluorescence signals on polyester and cotton that were not visualized by the orange goggles (61% of observations (n=11); exception: pure black fabric).

UV Light, Semen Stains, Saliva Stains

B148 Elemental Analysis of Biological Matrices by Solution Based High Resolution (HR)-ICP-MS and LA-HR-ICP-MS Analyses for Sourcing, Bone, Teeth, and Plant Matrices

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After attending this presentation, attendees will learn information about a laser ablation method for the analysis of biological matrices bone, teeth, and plant matrices by HR-ICP-MS as well as the possible use of elemental composition in addition to isotope ratios for sourcing bone, teeth, and plant matrices.

This presentation will impact the forensic community and/or humanity by demonstrating a fast and reliable elemental analysis of biological matrices using LA-HR-ICP-MS is presented. LA analyses will reduce the sample consumption and avoid tedious digestion procedures and how to source matrices like bone, teeth and plants as

well as showing how elemental composition of biological matrices could provide higher discrimination in addition to isotope ratios for sourcing.

Elemental analysis of glass and paint by ICP-MS and LA-ICP-MS have shown to provide a very high degree of discrimination between different sources of manufacturing of these materials. There has also been an interest in the application of elemental analysis by these sensitive methods to the analysis of biological matrices such as bones, hair, nail, teeth and plants. Isotope ratio analyses of several elements have also been used as geological markers, making possible the investigation of the origin of bones of human remains¹⁻³ and of plant material.⁴⁻⁵ Trace element content could provide a high degree of discrimination for the sourcing of bones and marijuana plants in addition to the use of isotope ratios. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is one of the preferred techniques for elemental analysis since it can provide excellent sensitivity, accuracy and precision of the analysis. The use of a sector field High Resolution (HR-ICP-MS) system offers the resolution of polyatomic interferences improving the detection of trace elements in complex matrices such as bones and marijuana samples, in addition to improving the detection limits over a quadrupole based ICP-MS device. By coupling a laser ablation (LA) system for solid sampling, the sample preparation steps and the destruction of the sample are reduced significantly. The advantages and disadvantages of coupling LA to the HR-ICP-MS are presented along with a comparison of the analytical data retrieved from solution and LA-based analyses.

The Standard Reference Materials (SRMs) NIST 1486 (bone meal), NIST 1400 (bone ashed) and NIST 1515 (apple leaves) were analyzed to develop and evaluate an analytical method for these matrices by HR-ICP-MS and LA-HR-ICP-MS. For this work a high resolution sector field instrument (Element 2) from Thermo Electron Co., Bremen, Germany and a Nd:YAG laser operating at 266 nm from CETAC, USA were used for the analysis of the SRMs and the bone and marijuana samples. The method for solution analysis was developed and validated in terms of sensitivity, accuracy and precision while additional parameters were taken into account for the LA method (spot size, carrier gas, repetition rate, and laser energy). Humerus and femur bone samples from different individuals and marijuana plant samples from different growing regions were analyzed with this developed method. The resulting significance of elemental analysis of these biological matrices for sourcing purposes is presented.

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Elemental Analysis, Biological Matrices, LA-HR-ICP-MS

B149 Electrospray-Ionization Mass Spectrometry for Exploitation of Sequence Variation in Human Short Tandem Repeats

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The goal of this presentation is to demonstrate the use of Electrospray-Ionization Mass Spectrometry (ESI-MS) to exploit sequence variation in human short tandem repeat loci (STRs). This information provides another dimension of discrimination between STR alleles sharing the same number of repeat units. Preliminary studies have successfully demonstrated correct allele assignments of common CODIS STR loci in multiplexed PCR reactions using DNA extracted from buccal and blood samples. A substantial number of variant alleles were observed that contain polymorphisms within alleles of the same length.

This presentation will impact the forensic community and/or humanity by providing an automated mechanism capable of screening a large collection of samples and derive maximal information from partial STR profiles.

In cases where nuclear DNA is damaged or limited, standard STR typing is often difficult and may yield partial profiles. Short STR loci offer an advantage over longer STR loci for PCR amplification in such cases due to increased likelihood that the shorter DNA stretch will be unbroken. Moreover, several of the common CODIS STR loci display polymorphisms between alleles of the same length that are not differentiated with the current standard STR typing technologies. In cases where a limited number or only short STR loci are efficiently amplified, or when comparing profiles of relatives across generations (such as a missing persons case), the ability to differentiate equal-length alleles with polymorphisms could provide the information to differentiate samples not discriminated by standard STR typing.

STR typing involves the PCR amplification of multiple short repetitive DNA units that display a collection of alleles in the human population that differ in the number of repeats. Typically, the products are analyzed in polyacrylamide gel or capillary electrophoresis using fluorescent detection methods. Different alleles for each locus are distinguished from each other based on PCR product length. Because multiple markers are utilized that are not genetically-linked, the product rule can be applied to estimate the probability of a random match to any STR profile where population allele frequencies have been characterized for each locus. This leads to extremely high levels of discrimination with potential random match probabilities of less than one in the human population. STR analysis has become the standard DNA analysis used in cases where sufficient nuclear DNA is obtainable to provide an STR profile.

In certain situations, such as mass disaster victim identification, a large number of samples with varying DNA quality can be produced, many of which may produce only partial STR profiles. In such cases, the ability to exploit polymorphisms in alleles can increase the observed allelic variation for several common STR loci. In addition, the development of an automated platform capable of high-throughput sample processing would provide a mechanism to process a large number of samples produced simultaneously or over a short time period, such as during a mass disaster or wartime. ESI-MS provides a platform capable of automated sample processing and analysis that will resolve polymorphisms between STR alleles. Accurate measurement of the mass of each product produced in a standard PCR reaction allows the

determination of the base composition (number of A, G, C, and T bases) of each PCR product. This not only provides the length of each allele, but also identifies polymorphisms within alleles. Moreover, high-resolution characterization of “off-ladder” alleles that sometimes complicate standard STR analysis is an inherent part of the ESI-MS approach. Importantly, the base composition of each STR allele can be associated specifically to existing allelic nomenclature and can be further annotated with observed polymorphisms.

Preliminary studies have been performed using DNA extracted from buccal and blood samples. Multiplex PCR reaction sets have been developed that amplify nine core CODIS STR loci and the sex marker, Amelogenin. Correct allele assignments were confirmed by comparison of ESI-MS analysis results from blinded samples to truth data produced using standard STR typing techniques. A number of allelic variants that differ only in sequence polymorphisms were revealed. Moreover, several examples of heterozygous individuals were observed where standard STR typing labeled them homozygous because the alleles were the same length. The ESI-MS platform will provide an automated mechanism capable of screening a large collection of samples and derive maximal information from partial STR profiles.

Mass Spectrometry, Human Short Tandem Repeats, Base Composition Analysis

B150 The Recovery of DNA From Biological Stains Submerged in Salt Water

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After attending this presentation, attendees will understand the ability to recover mitochondrial and nuclear DNA from biological stains following exposure to a salt-water environment.

This presentation will impact the forensic community and/or humanity by providing a resource for comparison when attempting to recover a nuclear and/or mitochondrial DNA profile from evidentiary items that have been submerged in salt water.

This study examines the probative value of biological stains that have been submerged in salt water. The particular focus was to evaluate the recovery of nuclear and mitochondrial DNA from blood and semen stains submerged for up to 60 days. Prior to DNA analysis, presumptive color tests were performed on each biological stain. It was found that blood tested Kastle-Meyer (KM) positive up to 60 days submerged whereas semen tested Acid Phosphatase (AP) positive up to 5 days submerged.

Stain extracts were quantified in order to render a comparison of the mitochondrial and nuclear DNA yield. For mtDNA analysis, the extracts were amplified using the LINEAR ARRAY™ duplex PCR system and the amplified product was analyzed by agarose gel electrophoresis. Using this approach, the estimated yield from the bloodstains ranged from 25 ng/μL (1 day submersion) to <2.5 ng/μL (60 day submersion). However, no mtDNA was recovered from semen stains deposited on the cotton or denim substrates. Nuclear DNA was quantified by Real-Time PCR with the ABI Quantifiler™ Kit and the ABI Prism® 7000 Sequence Detection System. With the exception of one sample (bloodstained denim submerged for 1 day, 0.710 ng/μL), the bloodstains gave low yields that ranged from 0.073 ng/μL – 0.002 ng/μL. Also of note, more than fifty percent of the bloodstains gave a zero yield. In contrast, the

semen stains gave high yields, ranging from 182.140 ng/μL to 0.238 ng/μL. Only one semen stain fell below the target input for genotyping (semen stain on cotton submerged for 6 days, 0.071 ng/μL). In general, the quantitation results obtained for nuclear and mitochondrial DNA reflect a decrease in yield as the submersion period increases.

Mitochondrial DNA polymorphisms were observed using the LINEAR ARRAY™ mtDNA HVI/HVII Region-Sequence Typing kit. A full LINEAR ARRAY™ mtDNA profile was obtained from bloodstained cotton and denim substrates following a submersion period of up to 60 and 25 days, respectively. These results will be compared to the STR profiles obtained following genotyping with the AmpF/STR® Identifiler® PCR Amplification Kit and the ABI Prism® 310 Genetic Analyzer.

This study demonstrates that, in principle, human mitochondrial and nuclear DNA can be recovered from biological stains that have been submerged in salt water. An important consideration that must be evaluated is the type of the biological stain (i.e., semen v. blood), which may dictate the most appropriate analytical approach.

Salt-Water, Mitochondrial DNA, Nuclear DNA

B151 Forensic DNA Typing of Envelopes and the Dye Quenching Phenomenon

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After attending this presentation, attendees will understand novel characteristics from envelopes when performing DNA typing procedures, and learn of means to troubleshoot problematic samples for DNA typing and analysis.

This presentation will impact the forensic community and/or humanity by allowing the forensic DNA community to troubleshoot problematic samples when it comes to envelope samples, and continue to keep lines of communication open within the community.

Introduction: With the recent expansion of the scope of DNA casework in forensic science, the processing of envelopes to elucidate a DNA profile has become a much more frequent endeavor. Envelopes sealed from licking can provide a low yield DNA sample that results in a full STR profile. Cuttings from the adhesive strip portion of the envelope are extracted, quantified, amplified, and analyzed using capillary electrophoresis. In a few isolated cases, the amplification products of the samples when electrophoresed on either the slab gel (377) or capillary (3100/3130) technology, the size standard became quenched. That phenomenon either produces low relative fluorescent units of the size standard or the entire sizing standards is absent in the data.

The purpose of this study was to try to determine the source of the size standard inhibition, to characterize the phenomenon, and to explore ways to obtain a full STR profile from problem samples.

Fingerprinting reagents can decrease the amount of DNA recovered. In a study done by members of the California Criminalistics Institute and the Latent Print Unit, they concluded that the majority of fingerprinting reagents (generally decreasing in DNA yield) did not inhibit the ability to obtain an STR profile from a bloody fingerprint in all test cases but one. It was found that a combination of “Stickyside” powder reagent and “Un-du” reagent was the only test scenario that gave no results.²

Ninhydrin (Triketohydrindane hydrate) is a chemical used to detect fingerprints on porous surfaces such as paper. Ninhydrin can be applied by dipping, brushing, or spraying the substrate. Ninhydrin reacts with free amines left over from proteins that are present in fingerprints, developing from a colorless liquid to a red/purple print only when exposed to high heat and humidity. The ninhydrin crystal is dissolved in HFE-7100, a CFC replacement consisting of a mixture of methyl

nonafluoroisobutyl ether and methyl nonafluorobutyl ether. Un-du Adhesive Remover is a product used in fingerprinting to dissolve adhesive portions of envelopes and stamps in order to search for fingerprints underneath sealed surfaces. The primary ingredient in Un-du is the chemical heptane, $H_3C(CH_2)_5CH_3$.

Materials and Methods: Five extraction sets were run, a total of 23 envelopes were used and 53 total cuttings/samples were created. Chemical treatment, envelope type, envelope processing technique and incubation time were varied throughout extraction sets. Envelopes were treated with ninhydrin and Un-du. Steam development was withheld from some ninhydrin treated envelopes. Two cuttings were taken from the adhesive strip of each envelope. Cuttings were approximately 1cm x 2cm. Some of these cuttings were then teased apart to reveal the adhesive material of the envelope while other cuttings were not teased apart. All cuttings were processed separately. Standard Connecticut State Forensic Laboratory protocol was used for DNA extraction, quantification, amplification, and analysis. Three different envelopes were used during the experiments: plain white envelopes, state forensic lab addressed envelopes, and plain cream colored envelopes.

Results and Discussion:

Extraction Set #1: Plain White Envelopes, Adhesive strip not teased apart, all envelopes licked

<u>Envelope</u>	<u>Cutting</u>	<u>Treatment</u>	<u>DNA Yield</u>	<u>Size Standard</u>	<u>Profile</u>
1	1	Un-du		Good	full
	2			Good	full
2	1	Ninhydrin, steam		Good	full
	2			Good	full
3	1	Nin+Un-du, steam	0.02 ng/ul	Good	partial (13 loci)
	2		0.00 ng/ul	Quenched	none
4	1	No chemicals		Good	full
	2			Good	partial (13 loci)

Extraction set 1 explored the effect of Un-du and ninhydrin on size standards and ability to obtain a full STR profile. All envelopes were plain white, adhesive strips were not teased apart, and all envelopes were licked. One cutting taken from an envelope treated with ninhydrin and Un-du with steam treatment was found to exhibit size standard quenching. In addition no profile was attained from this sample. Partial profiles were obtained from two other cuttings; however neither of these samples exhibited any kind of size standard quenching.

Extraction Set #2: State Envelopes, Adhesive strip teased apart, all envelopes licked

<u>Envelope</u>	<u>Cutting</u>	<u>Treatment</u>	<u>DNA Yield</u>	<u>Size Standard</u>	<u>Profile</u>
1	1	Un-du	0.02 ng/ul	quenched	none
	2		0.02 ng/ul	quenched	none
2	1	Ninhydrin, steam	0.02 ng/ul	quenched	none
	2		0.06 ng/ul	partially quenched	3 loci
3	1	Nin+Un-du, steam	0.02 ng/ul	quenched	none
	2		0.06 ng/ul	quenched	none

Extraction set 2 was done to further explore the effect of the fingerprinting chemicals on size standard quenching. State addressed envelopes were used, the adhesive strip was teased apart and all envelopes were licked. All cuttings were either fully or partially quenched. One cutting from the ninhydrin treated envelope exhibited partial quenching and yielded a partial profile. Only D8S1179, TPOX and Amelogenin loci had peak heights over calling threshold (50 RFU) for this sample.

Extraction Set #3: Plain White Envelopes, Adhesive strip not teased apart, all envelopes licked.

<u>Envelope</u>	<u>Cutting</u>	<u>Treatment</u>	<u>DNA Yield</u>	<u>Size Standard</u>	<u>Profile</u>
1	1	Un-du	0.12 ng/ul	good	full
	2		0.14 ng/ul	good	full
2	1	Ninhydrin, no steam	0.16 ng/ul	some quenching	full
	2		0.10 ng/ul	good	full
3	1	Ninhydrin, steam	0.12 ng/ul	good	full
	2		0.12 ng/ul	good	full
4	1	Nin+Un-du, no steam	0.26 ng/ul	good	full
	2		0.16 ng/ul	good	full
5	1	Nin+Un-du, steam	0.04 ng/ul	good	full
	2		0.08 ng/ul	good	full
6	1	untreated	0.24 ng/ul	good	full
	2		0.22 ng/ul	good	full

Extraction set 3 was done to further explore the effect of ninhydrin and Un-du on size standard quenching. Plain white envelopes were used, the adhesive strip was not teased apart and all envelopes were licked. Steam treatment, which is a necessary step during the ninhydrin treatment, was withheld from some of the envelopes. Sample 2-1 showed a subtle quenching pattern but still yielded a full profile. All other samples yielded a good size standard and full profile. DNA yield was consistent for all samples tested.

Extraction Set #4: Plain White, State, Plain Cream, Adhesive strip processing varied, Untreated with fingerprinting chemicals.

<u>Envelope</u>	<u>Cutting</u>	<u>Envelope Type</u>	<u>Adhesive Strip</u>	<u>DNA Yield</u>	<u>Size Standard</u>	<u>Profile</u>
1	1	plain white	teased apart	0.02 ng/ul	good	full
	2		not teased apart	0.00 ng/ul	good	full
2	1	plain white	teased apart	0.04 ng/ul	good	full
	2		not teased apart	0.16 ng/ul	good	full
3	1	state	teased apart	0.08 ng/ul	good	none
	2		not teased apart	0.06 ng/ul	good	full
4	1	state	teased apart	0.08 ng/ul	good	full
	2		not teased apart	0.08 ng/ul	good	full
5	1	plain cream	teased apart	0.10 ng/ul	good	none
	2		not teased apart	0.04 ng/ul	good	full
6	1	plain cream	teased apart	0.18ng/ul	good	full
	2		not teased apart	0.04 ng/ul	good	full
7	1	plain white	Un-licked		good	none
8	1	state	Un-licked		good	none
9	1	plain cream	Un-licked		good	none

Extraction set #4 explores the possibility that the envelope type and processing method may result in size standard quenching. All three types of envelopes were used for this experiment and samples were processed by either teasing apart the adhesive strip or maintaining the strip as is. None of these envelopes were treated with fingerprinting chemicals.

None of the samples exhibited size standard quenching. DNA yield was fairly consistent with the exception of two samples that yielded no profile at all, despite relatively high DNA yield.

Extraction Set #5: Cuttings taken from previous “problem” envelopes (around original cutting), extraction incubation time varied.

<u>Envelope</u>	<u>Cutting</u>	<u>Incubation Time</u>	<u>DNA Yield</u>	<u>Size Standard</u>	<u>Profile</u>
Set2, Envelope #1	1	1 hr	0.04 ng/ul	quenched	none
	2	18 hr	0.16 ng/ul	good	full
Set2, Envelope #2	1	1 hr	0.18 ng/ul	partially quenched	partial (11 loci)
	2	18 hr	0.10 ng/ul	partially quenched	partial (7 loci)
Set2, Envelope #3	1	1 hr	0.02 ng/ul	quenched	none
	2	18 hr	0.20 ng/ul	good	full
Set1, Envelope #3	1	18 hr	0.04 ng/ul	good	full
	2	1 hr	0.00 ng/ul	quenched	none

Extraction set 5 was done to determine if cuttings taken from surrounding regions of previous “problem” samples would also result in size standard quenching. Cuttings of about 1cm² were taken from both sides of a “problem” cutting and combined for testing. Set 1, envelope 3, cutting 1 was included as a sample that did not contain quenching in the original cutting, yet was on the same envelope as a “problem cutting.” Incubation time during extraction was included as another variable. Many of the cuttings yielded very similar results to their corresponding “problem” cuttings with

a few exceptions. Envelope 1, cutting 2 resulted in a good size standard and full STR profile. Envelope 2 yielded two partially quenched samples that both yielded partial profiles. Cutting two from the third envelope from set 2 yielded a good size standard and full profile. The sample that was not taken from a “problem area” did not exhibit any kind of size standard quenching. In general, the long (18 hour) incubation time resulted in samples that did not exhibit quenching. Two out of three cuttings taken from “problem” areas and incubated 18 hours were found to exhibit no size standard quenching. The third cutting was only partially quenched. While this could be coincidence, further exploration of incubation time might be useful. In general this evidence suggests that the source of the size standard quenching is not homogeneous across the adhesive strip of “problem envelopes.”

Extraction set 6 attempted to answer the question of whether or not the adhesive strip is causing the quenching. In addition this experiment explored the effects of the fingerprinting chemicals. One state addressed envelope was used for this experiment. Adhesive strip cuttings were teased apart for one of the two adhesive strip cuttings for each chemical condition. Initially, the adhesive strip was licked and the envelope sealed. The entire back side (seal side) was then licked. Four cuttings were then taken, two of the adhesive strip and two from non-adhesive portions of the licked envelope. After these cuttings were taken the back of the envelope was treated with ninhydrin and four more cuttings were taken as before. Next, the back of the envelope was treated with Un-du. Finally, four more cuttings were taken; two from the adhesive strip and two from non-adhesive portions of the chemically treated envelope surface.

Extraction Set #6: State envelope, adhesive strip not teased apart, cuttings taken from licked adhesive strip and licked non-adhesive surface, all samples incubated for 1 hour.

<u>Cutting</u>	<u>Surface</u>	<u>Treatment</u>	<u>Adhesive Strip</u>	<u>DNA Yield</u>	<u>Size Standard</u>	<u>Profile</u>
1	Adhesive	none	teased apart	2.04 ng/ul	Good	Full
2	Adhesive	none	not teased	.64 ng/ul	Good	Full
3	Non-Adhesive	none	N/A	1.18 ng/ul	Good	Full
4	Non-Adhesive	none	N/A	.38 ng/ul	Good	Full
5	Adhesive	Ninhydrin	teased apart	.18 ng/ul	Good	Full
6	Adhesive	Ninhydrin	not teased	.22 ng/ul	Good	Full
7	Non-Adhesive	Ninhydrin	N/A	.14 ng/ul	Quenched	none
8	Non-Adhesive	Ninhydrin	N/A	.14 ng/ul	Quenched	none
9	Adhesive	Un-du (w/ Nin)	teased apart	.12 ng/ul	Good	Full
10	Adhesive	Un-du (w/ Nin)	not teased	.12 ng/ul	Good	Full
11	Non-Adhesive	Un-du (w/ Nin)	N/A	.14 ng/ul	Partially	none
12	Non-Adhesive	Un-du (w/ Nin)	N/A	.12 ng/ul	Quenched	none

Extraction set six demonstrated that non-adhesive cuttings could also result in quenching. Of the four partially or fully quenched samples all were cuttings taken from non-adhesive strip areas of the envelope. All cuttings taken from the adhesive strip resulted in a normal size standard. Fingerprinting chemical treatment resulted in far lower DNA yield than untreated cuttings. The average DNA yield for untreated cuttings was 1.06 ng/ul, while the average DNA yield for cuttings taken after ninhydrin treatment was 0.15 ng/ul. In addition, only after treatment with ninhydrin was any quenching noted.

The QIAquick PCR Purification procedure was successful in eliminating size standard quenching in all samples processed. Resulting samples yielded partial STR profiles. In general, samples showed expected alleles with peak heights ranging from 100-500 RFU at the following 5 loci: Amelogenin, D8S1179, TH01, vWA, TPOX. Expected allele peak heights ranging from 10-50 RFU were detectable at the following 5 loci: D21S11, D16S539, D2S1338, D19S433, D5S818. No peak heights were detectable at the following 6 loci: D3S1358, D13S317, D7S820, CSF1PO, D18S51, FGA. The pattern of peak heights and loci dropout does not correlate to the DNA fragment size of the loci.

NaOH treatment was unsuccessful in removing size standard quenching in all three test samples. The QIAquick PCR Purification procedure was then performed on these samples. Once again the procedure was successful in getting rid of size standard quenching phenomena, however once cleaned there was no STR profile at all. The lack of STR profile might be explained by the loss of DNA characteristic of the NaOH treatment. The fact that the treatment was unsuccessful in removing the quenching suggests that the compound of interest does not intercalate exclusively into double stranded DNA.

Only envelopes treated with the fingerprinting chemicals were found to exhibit any kind of size standard quenching. It seems likely that the fingerprinting chemicals increase the chances of finding this phenomenon. There was no definitive pattern to the size standard quenching based on other variables induced. Cuttings from the same envelope may not exhibit the same result. Extraction set 6 showed that the adhesive strip is likely not the source of the quenching.

It seems likely that the fingerprinting chemicals are causing the size standard quenching phenomena. In addition the fingerprinting chemicals appear to generally decrease DNA yield. Chemical analysis of extracted DNA may be necessary to determine the chemicals responsible for the size standard quenching. An alternate method for envelope processing may be necessary. It may be advisable for future cases to take cuttings of envelopes for DNA before exposing the envelope to fingerprinting chemicals.

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DNA, Envelopes, Dye Quenching

B152 Over 300 Y-STR Cases — What Have We Learned?

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The goal of this presentation is to educate the attendee about when Y-STR testing is appropriate and the effectiveness of Y-STR analysis, as well as provide them with a better understanding of what to expect with Y-STR statistics.

This presentation will impact the forensic community and/or humanity by educating the community regarding Y-STR analysis so they learn how to effectively utilize Y-STR testing in their own laboratories. Following this presentation, attendees will learn of Orchid's Y-STR experience and be able to evaluate their own Y-STR laboratory practices to see how they compare.

The number of cases submitted for Y-chromosome STR testing has increased as the forensic and jurisprudence communities have become more informed as to the advantages of Y-STR analysis. The Y-chromosome is passed from father to son in an unchanged form. Therefore, all males originating from the same lineage exhibit the same Y-chromosome profile. Y-STR testing is used to detect the presence of male DNA and is primarily employed when the amount of female DNA greatly overwhelms the amount of male DNA present in the sample, when few or no sperm cells are detected, when a differential extraction cannot be performed, to determine the number of male contributors to a sample, or when autosomal STR testing has yielded little or no male DNA profile. Since implementing Y-STR testing in the fall of 2002, Orchid Cellmark's Dallas laboratory has performed Y-STR analysis in more than 300 cases. The samples submitted for Y-STR testing include those from active forensic casework, cold cases, post-conviction cases, kinship studies, and samples analyzed for historical purposes. The data from these cases (submitted for Y-STR testing between 2002-2006) have been compiled and analyzed. The present study highlights several points of interest including: 1) what types of evidentiary samples were submitted for testing, 2) how much male DNA was present in each sample based on a male-specific quantitation assay, 3) which Y-STR multiplex was used, 4) was male DNA detected, 5) how many Y-STR markers yielded a result, 6) were mixtures prevalent, 7) was the suspect excluded as a possible contributor to the evidence, and 8) what statistics (if applicable) were generated. The data presented will help educate and inform the forensic community as to the effectiveness of and opportunities afforded through Y-STR testing, as well as provide the community with a better understanding of the statistical outcomes of such analyses.

Y-STR, DNA, Forensics

B153 Revisiting Old New York City Sexual Assaults for CODIS Purposes

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After attending this presentation, attendees will understand how one DNA lab closed a previous loophole in STR testing of sexual assault evidence, augmenting databasing and prosecutorial efforts.

Other laboratories may also choose to reexamine old cases tested in the pre-CODIS era, in order to upload profiles from such cases into the CODIS database. This presentation will impact the forensic community and/or humanity by demonstrating possible positive outcomes include more "hits" and convictions.

Prior to 1990, the New York City Office of the Chief Medical Examiner's (NYC OCME) serology lab solely performed testing on homicide cases. Sexual assault evidence was at that time the purview of the police department lab. Throughout the 1990s, technology used in the new Department of Forensic Biology evolved from DQ-alpha to RFLP to finally STRs in 1996-1997 when the British AQuad@ system and ABlue and Green@ were brought online. Concurrently, the lab staff had been growing to take on extra workload. From 2000-2004, reported sexual assaults outnumbered homicides approximately two to one in New York City.

In 1997 a pilot project was started at OCME in cooperation with the district attorneys' offices and the police department to perform DNA testing on "selected" rape cases (10 per month). By mid-1998, the project included one-third of all (then-current) sexual assault cases within the city, and by that September, 2/3 of those cases, and on January 1, 1999, all of these cases. In recent years, reported sexual assaults have outnumbered homicides, about 3:1 (5 years ago when there were more homicides, the ratio was approximately 2:1).

Lab testing on sexual assault evidence in 1999 consisted of semen identification, and then triaging based on other case information. For cases with a listed suspect, semen-positive items were STR-typed. If the kit was negative, non-kit items such as victim's clothing or bedding were examined only as needed. For cases with no suspect, Y-STR testing was performed on kit items, but additional items were not examined. Current lab procedure is to perform STR testing with the goal of developing CODIS profiles in all semen positive cases; additional evidence is generally examined if no CODIS profile is developed on kit items.

New York City began entering profiles into the New York State CODIS database in 2000. In the intervening years, approximately 11,500 evidence profiles have been uploaded, approximately 75% of which are from sexual assaults. Thousands of "hits" in the database have led to hundreds of indictments and convictions.

The New York City Backlog project, which began in 2000, used commercial DNA labs to perform DNA testing on some 16,000 sexual assault kits, which had been kept in storage from cases that had occurred before January 1, 1999. This project has been described in detail in previous AAFS posters and presentations by OCME lab members. One flaw in this project was that if the kit had been tested at OCME during the early years of OCME's testing of sexual assault items, the semen-positive stains and swabs would have been in retained storage at the OCME when the kits were shipped to the contract labs from the police property warehouse.

Many cases from 1998-99 tested by the OCME had only had semen testing; reports were issued stating semen was found, and nothing further had been done (or, when the kit was subsequently sent to the contract lab, no further testing was possible since the positive samples were not in the box). Still more had only had Quad or Blue and Green done, so although a statistical uniqueness may have been reached, these cases were not tested with CODIS-eligible systems and thus could not be uploaded.

In 2004 an effort was begun to identify cases of this sort, perform further testing as needed, and upload the cases to CODIS. Existing DNA extracts were used when possible, but if no more remained (or if no DNA testing had previously been undertaken); the retained stains were cut for differential extraction and DNA typing. Work was concentrated on non-suspect cases.

Approximately 140 such cases were identified for further testing. About one-third of the cases targeted in this project yielded a CODIS-eligible profile where none had been had before. Further information regarding upload data and prosecutorial efforts will be offered.

Sexual Assault Kit, STR Testing, Old/Cold Cases

B154 Autosomal STRs Data on Two Aboriginal Populations of Guatemala

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After attending this presentation, attendees will learn data and parameters of forensic interest (HWE, PD, PE) of the Kiche and Qeqchi aboriginal Guatemala population for the 15 STR loci included in the Identifiler kit (Applied Biosystems - ABI). These data are of great interest for the forensic community, since they are necessary to perform statistical calculations, both in the paternity and forensics fields, after DNA identification analysis.

This presentation will impact the forensic community and/or humanity by providing exact and reliable data to perform appropriate statistical calculations in forensic and paternity cases, and also for anthropological studies.

Short tandem repeat (STR) loci are the most informative PCR-based genetic markers available to date for attempting to individualize biological material. The CODIS system includes 13 of the most informative STR loci available that can be amplified simultaneously using different available commercial kits.

In order to establish the appropriate statistical calculations for paternity and forensic cases, it is necessary to generate independent databases for all different populations, including the aboriginal populations, since some allele frequencies are statistically different from the mestizo general populations of the geographical areas where they are set.

Guatemala is the largest country in Central America, and its total population approximately twelve million (12,000,000) people, most of them mestizo population. There are several aboriginal populations, and the Kiche and Qeqchi groups are the largest ones, and represent approximately 750,000 and 475,000 individuals respectively.

This paper presents allele distribution data in the two main aboriginal populations from Guatemala. The data demonstrate that these loci can be useful for providing estimates of the frequency of a DNA profile in forensic identity testing and that a multiple locus profile is extremely rare in all the population.

Blood samples were obtained from 50 Kiche and 50 Qeqchi unrelated individuals (N=50) residing in Guatemala, and spotted on FTA® paper (Whatman, Florham Park, NJ). DNA samples were purified and amplified for the 15 loci included in the AmpF/Ip Identifiler® kit (Applied Biosystems, Foster City, CA). Samples were analyzed using the ABI Prism™ 310 Genetic Analyzer (PE Biosystems, Foster City, CA) according to the manufacturers' recommended protocols.

All 15 loci are highly polymorphic in both aboriginal populations.

For the Kiche group, the highest heterozygosity is shown by the D21S11 and D2A1338 loci, with a value of 0.880 in both. The most discriminating loci are D18S51 (PD 0.988) and FGA (0.948). The combined probability of exclusion for the 15 STR loci is 0.9999905.

For the Qeqchi group, the highest heterozygosity is shown by the FGA locus (0.88) and by the D21S11 locus (0.86). The most discriminating loci in this population are D18S51 (PD 0.951) and FGA (0.948). The combined probability of exclusion for the 15 STR loci is 0.9999943.

A resume of the PD and PE are shown in these tables:

KICHE POPULATION RESULTS

Locus	PD (Obs)	PD (Exp)	PE
1 D8S1179	0.90720000	0.90999226	0.55322870
2 D21S11	0.92160000	0.93949044	0.63145665
3 D7S820	0.86080000	0.86225572	0.45552161
4 CSF1PO	0.85040000	0.86339508	0.45965489
5 D3S1358	0.70320000	0.74253556	0.30551385
6 THO1	0.78000000	0.77330634	0.33111315
7 D13S317	0.92880000	0.93952164	0.63121708
8 D16S539	0.90000000	0.89997556	0.52859863
9 D2S1338	0.91840000	0.93838408	0.62846046
10 D19S433	0.93440000	0.94435326	0.64706071
11 vWA	0.83120000	0.84778954	0.43906759
12 TPOX	0.81120000	0.82236666	0.39062732
13 D18S51	0.94880000	0.95797906	0.69273671
14 D5S818	0.83360000	0.83061556	0.41482609
15 FGA	0.94800000	0.95998312	0.70014183
Total	>0.99999999	>0.99999999	0.99999055

QEQCHI POPULATION RESULTS

Locus	PD (Obs)	PD (Exp)	PE
1 D8S1179	0.91760000	0.93016618	0.60471043
2 D21S11	0.90400000	0.92812984	0.60027251
3 D7S820	0.87040000	0.89459556	0.52115496
4 CSF1PO	0.82080000	0.84799684	0.43574904
5 D3S1358	0.72640000	0.74592276	0.31294708
6 THO1	0.72160000	0.77057716	0.32637633
7 D13S317	0.93040000	0.93643780	0.62195132
8 D16S539	0.90480000	0.89938336	0.52605302
9 D2S1338	0.90960000	0.92523294	0.59183097
10 D19S433	0.93360000	0.94746280	0.65566656
11 vWA	0.88320000	0.90991524	0.55630269
12 TPOX	0.82160000	0.81669844	0.38157896
13 D18S51	0.95120000	0.96693342	0.72771031
14 D5S818	0.86640000	0.86787364	0.47172256
15 FGA	0.94800000	0.96278862	0.71103911
Total	>0.99999999	>0.99999999	0.99999433

In conclusion, two independent databases have been established for 15 STRs loci (including the 13 CODIS core loci) for the aboriginal Kiche and Qeqchi populations of Guatemala. All loci are highly polymorphic and can be used for human identification investigations.

Forensic Science, STRs, Guatemala

B155 Mitochondrial DNA Population Data From El Salvador (Central America)

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After attending this presentation, attendees will learn the mitochondrial DNA data from 142 unrelated mestizo individuals from El Salvador, and their utility for human identification and population or anthropological studies.

This presentation will impact the forensic community and/or humanity by demonstrating the importance of specific data from different populations in order to perform more exact statistical calculations in forensic science, paternity analysis, and human evolutionary studies.

Mitochondrial DNA has been studied extensively in order to describe human variation, population substructure, and infer information about human migration patterns. There are several characteristics of mitochondria that make them useful for these roles. Mitochondria are maternally inherited and their genome is believed to be free of

recombination. Therefore, the mitochondrial genome can be treated as a single locus with an effective population size that is ¼ of the size for nuclear autosomal genes. MtDNA also has been observed to have high mutation rates which contribute to the high levels of variability. Within the mitochondrial DNA the hypervariable regions (HVI and HVII) are thought to evolve particularly rapidly. The HVI includes nucleotide positions 16024 to 16365. The HVII includes nucleotide positions 73 to 340.

The high variability in mtDNA sequence has been used by forensic scientists for identity testing in both criminal and missing person cases. When one cannot exclude that an evidence sample and a reference sample may originate from the same source based on mtDNA analysis, an inference of the rarity of the sequence is required. To estimate the frequency of a mtDNA profile, population databases are used in forensics.

In this study the population of El Salvador, Central America was used as the target of analyses, due to the fact that there are not previous studies on this type of genome for this country. The population of El Salvador is composed by a 90% of mestizo (Amerindian-Spanish), 1% Amerindian and 9% white people. Samples of 142 unrelated mestizo individuals living in San Salvador were collected. DNA from blood or saliva was analyzed to get sequences of HVI and HVII following previous international recommendations. The extraction method used was the FTA® cards (Whatman, Florham Park, NJ). DNA was purified in a 1.2 mm punch, according to the manufacturer recommendations, followed by amplification with the correct primers that covered the positions 16024-16365 for HVI and 73-340 for HVII. Sequencing was carried over in an ABI 310 (Applied Biosystems, Foster City, CA) using Big Dye terminator v1.1 kits.

This table shows the polymorphisms observed more than one time, as well as the haplogroup to which they belong.

mtDNA HVI region	mtDNA HVII region	Times observed	Haplogroup
111 209 223 290 319 362	73 146 153 235 263 309+C 315+C	3	A
111 223 290 299 319 362	73 146 153 235 263 309+C 315+C	3	A
153 223 240 290 319 362	73 146 153 235 263 309+C 315+C	2	A
111 290 319 362 391	73 146 153 235 263 315+C	2	A
111 223 290 319 362	73 146 153 235 263 309+C 315+C	6	A
183 189 193+CC 223 259 298 325 327	73 195 249d 263 290d 291d 315+C	2	C
111 187 223 290 319 362	73 146 153 235 263 309+CC 315+C	2	A
111 223 290 319 362	73 146 150 235 263 315+C	2	A
183 189 223 259 298 325 327	73 195 249d 263 290d 291d 315+C	2	C
111 223 290 319 362	73 146 152 153 197 235 263 309+C 315+C	2	A
223 290 311 319 362	73 146 153 235 263 309+C 315+C	2	A
111 187 223 290 319 362	73 146 153 235 263 309+C 315+C	2	A
111 223 290 319 362 391	73 146 153 235 263 309+C 315+C	4	A
111 172 223 256 290 319 362	73 146 153 195 235 263 309+CC 315+C	2	A
111 223 290 319 362	73 146 153 235 263 309 309.2C 315.1C	2	A
223 290 319 362	73 146 153 235 263G 315.1C	2	A
75 111 223 290 319	73 146 153 235 263 309.1C 315.1C	2	A

Out of the 142 samples there are 100 unique haplotypes; there are 13 haplotypes found twice (1.41%), two haplotypes found three times (2.11%), one haplotype found four (2.82%) times and another one found six times (4.22%). Most of the samples belong to haplogroup A, haplogroup C being the second most frequently observed group.

These data show enough variability of the population from El Salvador for the mitochondrial DNA hypervariable regions one and two, and hence they support the use of mtDNA analysis for identification purposes.

Mitochondrial DNA, Forensic Science, El Salvador

B156 Median Network Analysis of mtDNA Haplotypes in the Basques of Southern Idaho

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After attending this presentation, attendees will gain an appreciation of the role of genetic drift (and specifically the founder effect) as it affects genetic variation and haplotype frequency in a specific sub-population, the immigrant Basque population of southern Idaho. Attendees will learn how median network representations of mutational differences between haplotypes can be used to infer the genealogical relationships among sequences.

This presentation will impact the forensic community and/or humanity by demonstrating that through migration and settlement of human populations, the regional pattern of genetic profiles can be explained as an admixture of specific lineages of the founding populations. Genetic profiles of the population are estimated in this study by mitochondrial DNA sequences of the first and second hypervariable segments (HVS1 and HVS2).

This non-coding region of mtDNA is known to have a much higher mutation rate than nuclear DNA, and thus lineage-specific mutations can be used to characterize sub-populations, and in some cases even identify individuals (for example, the remains of the Romanov family). The specific objectives of this study are as follows:

- 1) create a median network representation of Basque HVS sequences and their mutational distances from each other (haplotype network)
- 2) infer genealogical relationships between Idaho and European Basque maternal lineages

The Basque are a culturally and linguistically distinct sub-population within Europe. Characterized by a long-standing independent political history, and a unique language (not known to be related to any other extant language), the Basque people have long been of interest to scholars studying the genetic diversity of Europeans.

To collect samples for this study, individuals of Basque heritage from Idaho volunteered a buccal swab, from which mtDNA was extracted using the Qiagen Mini-Amp DNA kit. The hypervariable segments of the mtDNA control region were then PCR amplified, and sequenced using a LICOR 4300 DNA Analyzer. To ensure samples were from people of maternal Basque heritage, a questionnaire protocol was followed: each volunteer filled out a questionnaire, and the maiden names and birthplaces of their mother and their mother's mother were recorded. Only samples that have a recognizably Basque maiden name for their maternal grandmother were considered for this study. A median network was created using the program Network 4.0, distributed by Fluxus Engineering.

mtDNA, Haplotype Frequencies, Median Network

B157 Validation of a New and Improved Human Genotyping Multiplex Containing the 13 CODIS Loci, Amelogenin and Three Additional New Loci

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After attending this presentation, attendees will see the utility of using an alternative human genotyping multiplex, which is potentially

cheaper and more efficient than commercially available kits. This new method uses locus-specific DNA molecules to bracket the true alleles. These act as both a size standard and as an allelic ladder, with each bracket containing DNA molecules that are one repeat shorter and one repeat longer than the amplified alleles. Therefore, when co-electrophoresed with the true alleles, their sizing has potential to be more accurate. The new kit includes the 13 CODIS loci, the gender-identification locus amelogenin as well as 3 new loci (SE33, D2S1772 and D7S3048).

This presentation will impact the forensic community and/or humanity by offering a cheaper alternative to human genotyping, and this is especially important with the backlog of DNA samples to be done and the financial burden on crime labs, as well as an alternative to costly commercial kits for paternity testing organizations.

Short tandem repeat (STR) characterization has established itself as the principal method for human forensic DNA typing. STRs are distributed throughout the human genome, and are useful because of their conformance to Hardy-Weinberg equilibria, and have a relatively low mutation rate. Newer methods are being developed which may be advantageous, but because of the current database of convicted offenders which have been typed using the 13 CODIS (Combined DNA Index System) loci, a method which is improved over current ones but still uses the same loci is needed. Commercially available human identity and paternity kits such as Applied Biosystems Identifiler® or Promega's PowerPlex® are validated, but costly. In addition to being patent protected dye sets, they require an allelic ladder, which reduces the number of lanes or injections that can be used for samples, and an internal size standard, which increases the number of dyes required for a kit. A new kit, which uses locus-specific brackets (LSBs) to bracket the amplified alleles, are an improvement over existing kits. Because the internal size standard molecules can form a different secondary DNA structure, and carry a different dye than the sample alleles, their electrophoretic mobility responds differently from the sample alleles to a temperature shift. This can lead to a miscalled allele, especially with a microvariant. This new kit is less susceptible to this problem because it is sized using locus specific brackets, which serves as both a size standard and as an allelic ladder. Since each bracket is composed of DNA with the same repeat structure and dye as the locus of interest, it responds more like a sample allele to electrophoretic conditions.

A validation study was performed of an LSB multiplex kit including the 13 CODIS loci plus 3 additional STRs. DNA from blood and buccal swab contributed by 100 human subjects was amplified using the new kit and the Identifiler® multiplex. Amplified product was analyzed using Applied Biosystems 310, 3100-Avant, and 3130 genetic analyzers. There was complete agreement in the genotypes produced using either kit. In addition, the three new loci have been sequenced to verify their repeat number.

Human Identity Testing, Locus-Specific Brackets, DNA

B158 Differentiation of Biological Fluids Using Direct Analysis in Real Time (DART) Technology

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After attending this presentation, attendees will understand new technologies for identifying common biological fluids (saliva, blood etc).

This presentation will impact the forensic community and/or humanity by providing alternatives to the presumptive tests for biological fluids presently utilized in forensic serology, speeding up the identification process.

The identification of biological fluids at crime scenes poses a number of challenges. Current methods of identification of body fluids apart from being extremely time consuming and labor-intensive also have the risk of false positives. In the field of mass spectrometry the introduction of a new innovative ionization source, Direct Analysis in Real Time (DART) represents a significant breakthrough in analysis (JEOL-USA, Inc). Combined with the AccuTOF™ mass spectrometer, solids, liquids, and gaseous samples can be analyzed by placing the sample between the ionization source (DART) and the mass spectrometer. The DART can analyze samples directly on surfaces such as currency, food, pills, and clothing. Additionally, the instrument has been shown to detect a variety of substances in biological fluids including urine, blood, and saliva. The substances detected include drugs, amino acids, lipids, and metabolites.

In this project the DART is being used to distinguish between biological fluids that are commonly encountered in forensic casework analysis, namely blood and saliva. Preliminary data comparing swabs containing human blood and saliva indicate signature peaks for small molecules unique to each of the two biological materials. These profiles represent chemical species in m/z range of 50-2000. The present study will involve detection and comparison with presumptive tests for biological fluids. The method will be adapted to identify trace amounts of biological fluids on a variety of substrates (swabs, cloth etc). The ability to distinguish biological stains using mass spectrometry could be a useful alternative to the biochemical tests currently being utilized in forensic serology.

Biological Fluids, Mass Spectrometry, DART

B159 Comparison of the Bio-Rad iCycler iQ™5 and the Stratagene Mx3005P Real-Time PCR Systems in Conjunction With Promega's Plexor™ GI Prototype System for the Simultaneous Quantitation of Autosomal and Y-chromosome DNA

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After attending this presentation, attendees will have a basic understanding of how Promega's Plexor™ GI prototype kit works and how their laboratory could benefit from the use of the final product. Attendees will also understand the different qualities of the two real-time PCR instruments, helping them to determine which system might best suit the quantitation needs of their lab.

This presentation will impact the forensic community and/or humanity by providing insight into a new way of screening sexual assault evidence. This paper will also assist forensic labs in determining which real-time PCR instruments could best suit their quantitation needs.

Real-time PCR is a valuable tool in forensic DNA analysis, since it provides a large dynamic range, is automated and can be multiplexed for greater functionality. Moreover, real-time PCR has the ability to detect the amount of amplifiable human DNA in the sample. This provides a measure of DNA quality, providing the examiner with an idea of how well a sample may amplify during short tandem repeat (STR) typing.

Individualization of the male and female fractions of sexual assault evidence is an important step in the successful analysis of forensic casework. Unfortunately, differential extractions do not always succeed at completely separating the sperm and non-sperm fractions and single source STR profiles are not always attainable. Situations arise where the sperm cell DNA is retained in the non-sperm fraction, but the STR primers are overwhelmed by the excess of non-sperm DNA and the

sperm DNA in the mixture goes undetected. Situations such as these lend themselves to the use of Y-STR profiling which may be used to isolate and amplify the male DNA, even in the presence of high quantities of female DNA. Knowing that male DNA is present in the sample allows the examiner to make an informed decision to go forward with Y-STR profiling.

Commercial real-time PCR assays can be used to specifically quantify the autosomal and male DNA in a sample. The products currently available require a separate PCR amplification for the autosomal and male DNA quantitations. The necessity of performing two separate reactions for quantitation of autosomal and male DNA is time consuming, costly and requires backtracking unless both quantitations are performed on all casework samples. The Promega Corporation has recently developed a system which could help increase the efficiency of quantifying and triaging these sexual assault case samples. This system, Plexor™ GI Prototype, is a real-time PCR based assay which is able to quantify the autosomal and Y-chromosome DNA in a single PCR reaction.

The utility of the Bio-Rad iCycler iQ™5 and the Stratagene Mx3005P™ were tested using an *Alu*-based SYBR green assay, a multiplex Plexor™ GI Prototype assay (Promega), and a duplex real-time PCR assay developed by the Vermont Forensic Laboratory. DNA was extracted from blood cards, buccal swabs, tissue samples, and cigarette butts using the DNA IQ™ System and/or an organic extraction method. These samples were quantified using a SYBR Green assay on both instruments. The results showed, on average, a less than two-fold difference between the two instruments. When these results were compared to those obtained using AluQuant (Promega), both of the real-time instruments gave results that were an average of 2-fold higher than the AluQuant system. This comparison is consistent with the results shown by the 2004 NIST DNA quantitation study.

A variety of both male and female single source samples, as well as male/female mixture samples were analyzed using the Plexor™ GI Prototype kit and the Vermont Forensic Laboratory's duplex kit on both real-time instruments. The two duplex kits gave comparable results. A variation of the cycling parameters for Plexor™ GI Prototype was examined. The results suggest that Plexor™ GI Prototype hold times were adequate for maximum amplification efficiency. Both instruments provided comparable quantitation results with Plexor™ GI Prototype.

The comparison of the Bio-Rad iCycler iQ™5 with the Stratagene Mx3005P shows that the two instruments are very similar in their ability to accurately quantify the amount of DNA in a sample. A number of other factors were also examined to compare the two instruments, including ease of use, cost, and compatibility with other systems used in the laboratory. The evaluation of the Plexor™ GI Prototype kit is ongoing. However, the results are promising that this kit could help to increase laboratory efficiency when examining sexual assault cases.

Real-Time PCR, Multiplex Quantitation, Sexual Assault Case Screening

B160 An Analysis of Book Chapters to Develop an Academic Fingerprint Curriculum

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After attending this presentation, attendees will (1) understand the priority given to friction ridge topics in published literature as a model for developing forensic curriculum; and (2) learn a new model for textual topic analysis.

This presentation will impact the forensic community and/or humanity by demonstrating a stream-lined method based on public source data for structuring and developing new curricula for education and training.

Forensic science is a mixture of borrowed, albeit amended, natural science (biology, chemistry) and methods developed on its own (firearms, impression evidence); it also encompasses sciences, which bridge between these two. One of these ‘bridging’ sciences is friction ridge analysis. The study of friction ridges has a long history, from Purkinje to Faulds but was codified by Galton’s work in his landmark book.¹ The conversion from academic endeavor to police application changed the nature of the discipline, however; it drifted away from its open-ended research origins to a structured, standardized protocol. This type of change may ossify a science and prevent it from growing, maturing, and improving.

Curriculum in forensic science has been developed previously through Working Groups, such as the Technical Working Group on Education and Training in Forensic Science (TWGED) and its two progeny, TWGED—Digital Evidence and TWGED—Forensic Accounting and Fraud Investigation. These projects, while of enormous benefit to the participants, the discipline, and the relevant communities, are expensive and somewhat lengthy. An alternative method was developed for topics where a plurality of publications is available but no standardized curriculum exists.

A variety of books on friction ridge analysis were reviewed and analyzed for topics and content.²⁻¹¹ The chapters and subheadings were assigned numerical values in series to quantify their appearance, location, and order. Basic statistics were developed (mean, median, mode, standard deviation) to describe the topics’ priority (see below).

Mean		Median		Mode		Standard Deviation	
1.0	History	1	History	1	History	0	History
2.2	Skin	2	Skin	1	Skin	1	Testimony
3.9	Patterns	3	Formation	2	Classification	1.3	Skin
4.3	Formation	4	Classification	3	Formation	1.4	Light sources
4.3	Collection	4	Scars	4	Collection	2	individualization
4.5	Classification	4	Patterns	4	Patterns	2.1	Heredity
4.9	Persistence	4	Collection	5	Characteristics	2.1	Photography
5.0	Characteristics	5	Persistence	7	Individualization	2.3	Characteristics
5.3	Individualization	5	Characteristics	8	Errors	2.3	Patterns
5.7	Scars	5	Latent	8	Latent	2.4	Persistence
5.9	Latent	6	Individualization	9	Photography	2.5	Errors
7.0	Light sources	7	Light sources	9	Testimony	2.6	Collection
7.3	Development	7	Development	-	ACE-V	2.9	Latent
7.4	Photography	7.5	ACE-V	-	Development	2.9	Development
7.5	ACE-V	8	Photography	-	Heredity	3.1	Classification
8.3	Testimony	8	Errors	-	Persistence	3.2	Formation
8.5	Heredity	8.5	Heredity	-	Scars	3.5	ACE-V
8.5	Errors	8.5	Testimony	-	Light sources	3.8	Scars

This type of textual analysis can provide a “consensus” structure for developing forensic academic as well as laboratory and professional training curricula.

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¹ Galton, F.F.R.S., etc (2003). Finger Prints. Buffalo, New York, William S. Hein & Co., Inc.

² Ashbaugh, D.R. (1999). Quantitative-qualitative friction ridge analysis: an introduction to basic and advanced ridgeology. Washington, D.C., CRC Press.

³ Champod, C., C. Lennard et al. (2004). Fingerprints and other ridge skin impressions. Washington, D.C., CRC Press.

⁴ Chapel, C.E. (1941). Fingerprinting: a manual of identification. New York, Coward McCann, Inc.

⁵ Cowger, James F. (1993). Friction ridge skin: comparison and identification of fingerprints. Washington, D.C., CRC Press.

⁶ Criminal Justice Information Services Division, I. S. S. and U. D. o. Justice (1993). Fingerprint training manual. Washington, D.C., U.S. Government.

⁷ Cummins, P.D., Harold and M.D. Midlo, Charles (1961). Finger Prints, Palms and Soles: An introduction to dermatoglyphics. New York, Dover Publications, Inc.

⁸ Henry, S.E.R. (1913). Classification and uses of finger prints. London, Darling and Son, Ltd.

⁹ Justice, U. S. D. o. and F. B. o. Investigation (1984). The science of fingerprints: classification and uses. Washington, D.C., U.S. Government Printing Office.

¹⁰ Lee, H.C. and R.E. Gaensslen (2001). Advances in fingerprint technology. Boca Raton, FL, CRC Press.

¹¹ Olsen, Robert D., Sr. (1978) Scott’s fingerprint mechanics. Springfield, Il., Charles C. Thomas.

Friction Ridges, Curriculum, Quantitative Analysis

B161 An Update on the Scientific Working Group on Friction Ridge Analysis, Study, and Technology (SWGFAST) and West Virginia University Friction Ridge Sourcebook

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Attendees will be informed and updated on the development of the Friction Ridge Analysis Sourcebook, a project funded through the National Institute of Justice (NIJ) and conducted by SWGFAST and WVU.

This presentation will impact the forensic community and/or humanity by demonstrating the benefits of this type of reference collection. Information and updates on the International Association of Identification Library Collection housed at West Virginia University's Wise Library will also be presented.

With over 100 years of service in the court systems, friction ridge evidence and its reliability has recently been challenged. The lack of standardization and the lack of application of established standards have become the main issues disputed at length. To date, there is no single publication with current information on the history, morphology, methodology, classification, guidelines, processing, automation, equipment, quality assurance, and other vital areas of friction ridge evidence. The Friction Ridge Analysis Sourcebook will eventually become the written authority that the friction ridge community has long been lacking.

For over 10 years, the Scientific Working Group on Friction Ridge Analysis, Study, and Technology has maintained a consensus of standards in the friction ridge community by publishing documents and guidelines for friction ridge examination. Through sponsorship from the Federal Bureau of Investigation, SWGFAST has played an important role in addressing the current friction ridge issues and providing lists of research topics to be performed. It is the mission of the members to assist the latent print community in providing the best service possible to the criminal justice system.

This presentation is an overview of the Friction Ridge Analysis Sourcebook and its development. Experts in the various fields of friction ridge analysis were called to draft the individual chapters of the Sourcebook, thereby creating a bibliography of almost 900 sources. Many of these sources are out of print and are difficult to obtain. By collecting information from various geographic locations and publications, the Sourcebook will be able to bring a set of standards for terminology, methodology, training, and quality assurance to the entire forensic science community. Such standards would allow for a consensus among forensic scientists and coalesce the last century of recognizing friction ridge identification as a science. It will also provide an invaluable research tool to members of the forensic science community that do not have access to the out-of-print, archived materials.

As advancements are made within the science, it is anticipated that the Sourcebook will also be updated and re-distributed to universities, law enforcement agencies, forensic laboratories, and individual practitioners. New chapters will be added to support the latest discoveries or controversies in the field and any corrections will be made accordingly.

SWGFAST, Friction Ridge Analysis, Reference Collection

B162 Improving Multimetal Deposition (MMD) as a Fingerprint Detection Technique Through the Functionalization of Gold Particles

Andy Becue, PhD, Eric Stauffer, MS, Christophe Champod, PhD, and Pierre A. Margot, PhD, University of Lausanne, School of Criminal Sciences, Batochime, Lausanne, Vaud CH-1015, Switzerland

After attending this presentation, attendees will learn about the different possibilities in improving multimetal deposition (MMD) by functionalization of gold particles. They will be able to go back to their laboratory and put in direct practice these new formulas of MMD to detect fingerprints.

This presentation will impact the forensic community and/or humanity by demonstrating a second birth of multimetal deposition (MMD), which will greatly improve the contrast obtained with this enhancement technique. This leads to a better detection of fingerprints on both porous and nonporous surfaces. This could have a tremendous impact in a case involving the detection and enhancement of fingerprints.

Since its invention by Saunders in 1989, multimetal deposition (MMD) has been the subject of very little research. In 1999, Schnetz and Margot published a new formulation that led to improved fingerprint enhancement and more consistent results. Since that day, no other improvement has been presented for MMD.

MMD is a very sensitive fingerprint enhancement technique that has the great advantage to work on both porous and nonporous surfaces. Additionally, it leads to very detailed ridge impressions. It has the main inconvenience of being very labor intensive and requires the use of bidistilled water and siliconized glassware. The preparation of the solutions is long and tedious and the development procedure also requires intense labor. All this work would be worth it if the results were undeniably better than all other enhancement techniques. However, this is not the case. Gold colloids deposition must be followed by the application of a modified physical developer (silver particles) to obtain grey to black fingerprints. While this technique works great on many light-colored or transparent surfaces, the resulting contrast does not suffice to properly observe fingerprints on many patterned backgrounds.

In the last few years, new perspectives in the use of MMD have been proposed, researched, and developed in this laboratory. The strategy is based on the functionalization of the gold nanoparticles, either in solution or already deposited on the fingerprint, to build a molecular structure containing dyes or fluorophores. The relatively easy modification of gold nanoparticles opens the road to various different molecular structures offering their own capabilities. The ultimate aim is to significantly increase the contrast of the enhanced fingerprints.

In a first approach, gold nanoparticles were functionalized with cyclodextrins (CDs). CDs are cyclic oligosaccharides that have a truncated cone shape. They make great molecular hosts for organic molecules in aqueous solution. The native structure of the CDs was modified to include a thiol group that presents a very high affinity for gold. The 6-monodeoxy-6-monothio b-cyclodextrin was used to create self-assembled monolayers (SAMs) on gold. The dye Acid Blue 25 was used to enhance the print.

In a second approach, gold nanoparticles were used as docking sites for proteins. The idea behind this strategy is to be able to attach a fluorescent marker to the gold particle. Several mechanisms have been tried. Lately, the use of a spacer to ensure a covalent binding between the gold nanoparticle and the protein was attempted. In a first attempt, dithiobis (succinimidyl propionate) was chosen as it allows the building of SAMs on the gold nanoparticles through its thiol group and the binding of macromolecules to its other extremity. Other molecules have been explored.

Other venues regarding the functionalization of the gold and the fluorescent marker have also been thought of and will be presented.

Multimetal deposition as a development technique for fingerprints will be briefly reviewed. The attendees will be presented all the different functionalizations of gold nanoparticles that have been thought of and attempted. The results of the experiments will be presented and the advantages compared to the original formulation will be thoroughly explained. After the presentation, the attendees will have all the necessary information to implement these new formulations in their laboratory.

Fingerprint Detection, Nonporous and Porous Surfaces, Fingerprint Deposits

B163 Automated Fingerprint Identification System Calibration Study

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After attending this presentation, attendees will understand the principles of ensuring that an AFIS system is operating within statistical control. The methods, procedures and calculations for setting up the standards will be explained during the presentation. The concepts of process stability and calibration will also be linked to the operation of an AFIS system.

This presentation will impact the forensic community and/or humanity by presenting the requirements of ASCLD/LAB and ISO 17025 Laboratory Accreditation systems, which require that all instrumentation operating within a forensic laboratory should be calibrated prior to use. The utilization of AFIS systems within forensic laboratories does not receive the attention, which it deserves. The purpose of this paper is to demonstrate practical methods of achieving this requirement.

The Automated Fingerprint Identification System (AFIS) score of a fingerprint may be affected by its acquisition method. This can have a direct influence on the calibration and validation of the system. To better gauge the degree of effect, a series of fingerprints were processed using a Sagem-Morpho Metamorpho system controlling for the following criteria: the type of print (flat impression, lighter flat impression, tip and partial fingerprint), fingerprint classification, number of minutiae, image size, image position, and image rotation. The two main factors tested that related to acquisition were the process stability of the AFIS and rotation of the print. Process stability is a process that exhibits only common variation or variation resulting from inherent system limitations.

The process stability of the AFIS was tested by processing 100 replicates of each of the basic fingerprint classes (plain whorl, ulnar loop, radial loop, plain arch, and tented arch) through the system. The process stability was evaluated using statistical process control charts. Control charts provide tools to analyze the past, present and future states of a process. Analysis of trends, maintenance of present status, and prediction of instabilities and bottlenecks can greatly improve the quality of a process. Thus armed with a comprehensive understanding of a process, appropriate preventative measures can minimize variation and maximize stability.

In the rotation study, the flat impression from each fingerprint was rotated from -180° to $+180^\circ$ in 5° increments using Adobe Photoshop CS2. The resolution of these images was maintained at 500 pixels per inch, which is the acceptable resolution for AFIS. The resulting scores for each 5° rotation approximated a normal distribution. This indicates that there is an optimal orientation range for the acquisition of prints to ensure the best correlation score.

In the minutiae study, the number of minutiae from flat impressions was changed to determine the effect on the AFIS scores. For each fingerprint, the minutiae were automatically chosen by the AFIS. In each experiment, the minutiae were automatically encoded on the test print. A certain number of minutiae were then removed in a random manner and this process was replicated 25 times. At a certain point, the score generated by the target print becomes indistinguishable from the background score; the background is defined as the scores generated by non-matching fingerprints. This point then defines the minimum number of minutiae needed to make a potential AFIS correlation.

Selecting 33 minutiae from a potential 65 minutiae of a fingerprint will result in a vast number of combinations of minutiae. The number of combinations is defined as $\binom{n}{r} C$ where n is the population and r is the sample and thus $\binom{65}{33} C$ equals 3.6097×10^{18} combinations. The data were analyzed statistically to determine at what point the removal of the minutiae made a significant difference to the AFIS match score.

All data obtained in the studies performed yielded key information to allow AFIS users to be more aware of variation that may occur and how to maintain optimal stability in all facets of an AFIS system.

AFIS, Process Stability, Calibration

B164 Forensic Science and Biometrics: What's the Difference?

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After attending this presentation, attendees will understand the fundamental differences between forensic science and biometrics and their applications. The attendee will also learn how the various methods of personal identification are applied differently by these two fields.

Forensic science and biometrics are often confused because they apply similar technologies; their fundamental principles, however, are quite different. This presentation will impact the forensic community and/or humanity by making those differences clear to forensic scientists and to define the application and research territories of both disciplines. Confounding the two will obscure important applications, research, and funding; this presentation will dispel that confusion.

The terms "biometrics" and "biometry" have been used since early in the 20th century to refer to the field of development of statistical and mathematical methods applicable to data analysis problems in the biological sciences, such as the analysis of data from the yields of different varieties of wheat or data from human clinical trials evaluating the relative effectiveness of competing therapies for a disease. Recently, the term "biometrics" has also been used to refer to the emerging field of technology devoted to automated methods for authentication of individuals using physiological and behavioral traits, such as retinal or iris scans, fingerprints, hand geometry, face recognition, handwriting, and gait.

Biometric technologies are quickly being integrated in a broad range of secure identification and personal verification applications. Government and corporate IDs, secure electronic banking, retail sales, law enforcement, and health and social services are already applying biometrics as solutions. Because a biometric links an event to a particular individual (a password may be entered by anyone who knows it) and is convenient (you always have it with you), biometrics are becoming accepted by users and consumers.

Forensic science, on the other hand, is the application of the natural and physical sciences to questions of legal or public concern. The most common application is the analysis of evidence, such as blood, hairs, fibers, bullets, and fingerprints, from criminal cases like bank robberies, homicides, and kidnappings. The perpetrator is typically unknown at the time of the crime and, therefore, an investigation is required to reduce the list of possible suspects; sometimes the victim is also unknown and

must be identified through fingerprints, dental records, DNA, or some other forensic method. Many of these methods are meant to identify the deceased and, therefore, are more intrusive.

Forensic science and biometrics both apply various identification sciences, some the same and some unique to the particular discipline, although they do so for very different reasons (Figure 1). Biometrics uniformly applies to a *pre-event situation*, such as gaining access, surveillance, or verification. In this way, biometrics chooses which mode of identification will be used. Forensic science, however, applies to *post-event situations*; as a historical science, forensic science reconstructs past criminal events to assist adjudication. Because forensic scientists never know which mode of identification will be used ahead of time (DNA, fingerprints, dentition, etc), they must sort through all of the information to discern significant clues. This highlights another important difference between the two disciplines—the results of a forensic science report may ultimately end up in court, whereas those of a biometric analysis rarely do.

Distinctions such as these have important implications for the definition of and research agenda for both disciplines.

Forensic identification, Biometrics, Forensic Science

B165 Fractal Analysis of Fingerprints: A New Approach

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After attending this presentation, attendees will learn of a new approach to the analysis of fingerprints.

This presentation will impact the forensic community and/or humanity by demonstrating the analysis of fingerprints is not restricted to fingerprints but rather can be applied to the characterization of patterns in general, the implication for the forensic community are very broad.

The traditional approach to the analysis of fingerprints is local in the sense that relative positions of individual features, the minutiae, are measured and recorded. Subsequently, in the matching process, such a list is compared to other similar lists. This approach has a number of serious failings. First, this approach is qualitative and not quantitative. Secondly, efforts to automate the process have not been overly successful, for example, if the fingerprint is not properly aligned (i.e., rotated by a handful of degrees) the analysis will fail. Thirdly, if only partial fingerprints exist the local approach will also fail.

A global approach to the analysis of fingerprints is being developed. In this approach points in the fingerprint are randomly sampled and these random samplings are used to construct a unique fractal. In turn this fractal is analyzed using traditional mathematical techniques. As a consequence, this approach allows for quantitative comparisons of fingerprints. Moreover, the random sampling of the fingerprint is accomplished in a manner that is independent of the orientation of fingerprint and thus the difficulty associate with the orientation of the fingerprints is avoided. Due to the global nature of the method of analysis, partial prints can also yield results that are useful in effort of matching prints.

This presentation will outline this approach and introduce the Scale Spectrum of a fingerprint. This spectrum, which measures the scale of features within the fingerprint, is central to this method. It is a measure of global properties of the fingerprint and consequently can be constructed from partial prints. In addition it is defined do as to be independent of orientation.

Fingerprints, Fractals, Pattern Analysis

B166 Techniques in Drug Sampling

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After attending this presentation, attendees will understand various ready to use sampling techniques available in the scientific literature. Although in this presentation drug analysis is being used as an example, nevertheless the sampling techniques discussed here can be employed in any other situation, as they are quite generalized. No specific technique is suggested/recommended to any specific laboratory or person, as techniques vary depending on the purpose of usage and the local legal and scientific/technical requirements.

Unfortunately, as of today most of the forensic laboratories, involved in drug analysis, especially those in the big cities are 'buried' under the 'heaps' of drug cases waiting for analysis. With the aim to alleviate this present unhealthy situation, various sampling techniques available in the literature are reviewed. This presentation will impact the forensic community and/or humanity by demonstrating some very powerful techniques, which have the potential to solve the drug backlog problem, while at the same time fulfill legal/scientific requirements.

In recent times, with the increase in quality, there is also a tremendous increase in the quantity of the drugs being seized in the United States. This puts a large burden on the law enforcement agencies and especially the drug laboratories throughout the country. This entails a long and chronic backlog of cases to be analyzed by the concerned drug laboratories, which have to be cleared in a court specified time period.

This critical situation brings home the need to employ appropriate scientific/statistical sampling techniques, which would not only satisfy the legal requirements, but also help alleviate the present backlog problems.

A broad review is presented of the various sampling techniques available to a drug chemist to choose from, depending on the situation.

(i) Is a drug present in (more than) a specified proportion of the items? This means increased sampling; or (ii) Is a drug present in all the items? This means maximum sampling (this will require full analysis of all items, which will lead to unrealistic costs, especially for large number of units; or (iii) Is a drug present? This means minimal sampling (this may require one positive result). Selection of any of the above three criteria, depends on the chemist and also on the legal and scientific/technical situations.

Before selecting a sampling technique for its application, one has to ensure that two principles are maintained, which are quite important, viz: (i) the properties of the sample are a true reflection of the properties of the population from which the samples were taken, and (ii) each unit in the population has an equal chance of being selected.

Technical definitions concerning the sampling in a typical drug case, like seizure, population, unit, sample, mean (both mean of a population and sample) and standard deviation (both standard deviation of a population and sample), are explained.

The various sampling methods applied in drug laboratories in the United States and in other parts of the world include, $n=N$, $n=0.05N$, $n=0.1N$, $n=\text{square root of } N$, $n=\text{square root of } N/2$, $n=20+10\%(N-20)$ and $n=1$ (where 'n' is the sample size and 'N' is the total population) are shown. Advantages and disadvantages of each one of them are discussed.

The popular square root method recommended by International Drug Control Programme of United Nations and accepted by AOAC International, is also elucidated.

Broadly there are three major statistical sampling techniques, like the hypergeometric distribution, the binomial distribution and the Bayesian approach. Results obtained by applying hypergeometric distribution are discussed. Interestingly, with increasing sample size, the Law of Diminishing Returns (wherein, after certain proof (~70-80 %),

further increase in sample size does not concomitantly increase the number of positives) become more significant. Hence, as a caveat, the drug chemists should particularly bear this in mind, when deciding a sampling size.

Last but not least, the reason why sampling techniques are important in a given situation is highlighted by the following dramatic statement, "If one sample out of a population of 10 is taken, and the analysis of the sample shows cocaine, the hypothesis that this is the only one containing cocaine is much more unlikely (10 %) than the hypothesis that the majority of the 10 items contains cocaine (more than 50 %). (Source: European Network of forensic Science Institutes Drugs Working Group. "Guidelines on Representative Drug Sampling" 2003 P30).

Sampling Techniques, Hypergeometric Distribution, Drug Analysis

B167 Overview of Pharmaceutical Tablet Manufacturing and Counterfeiting Considerations

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The goal of this presentation is to provide attendees with an understanding of the manufacturing process of pharmaceutical tablets, noting aspects that are significant for detection of counterfeit products. Knowledge of the manufacturing process will allow examiners to make informed analyses and accurate inferences.

This presentation will impact the forensic community and/or humanity by demonstrating a comprehensive, detailed as a guide to those interested in the outcomes of the manufacturing process on the finished product. These concepts can then be applied to improve drug analysis and intelligence investigations.

Increased awareness of manufacturing processes will benefit the community by addressing the questions of why and how a product is developed. As an illustration, fiber analysts benefit from an understanding of the textile industry. Likewise, knowledge of manufacturing processes should precede examinations of physical evidence.

In addition to tableting techniques, attendees will also receive an overview of the tooling manufacturing process. The tableting process begins with tablet press tooling, which may be laser-etched or hobbled (cut, as the teeth of a gear). Depending on the machinery used, tablets may be produced one at a time, in batches of millions, or any quantity in between. In the Tableting Specification Manual, the American Pharmaceutical Association (APA) suggests guidelines for tooling, which are voluntarily followed by tablet press manufacturers in the United States and some international manufacturers. Tooling wear varies between products; some formulations are more abrasive than others. Fixed compression rates promote consistency between batches; therefore, preformulation studies strive for uniform formulations.

Formulations are composed of the active ingredients, binders, and excipients. A formulation is considered optimal if compression does not require a force that is abnormally high or low and the formulation does not stick to the punch face or abrade the tooling. The formulation is tested extensively before the product is manufactured in commercial quantities. In addition to the physical design, the tablet must also be pharmaceutically effective. The tablet ingredients must bind well enough to produce a functional tablet that will not easily fracture while maintaining bioavailability of the active drug upon dissolution of the tablet.

According to the Food and Drug Administration's (FDA) Counterfeit Drug Task Force Report—2006 Update, "Counterfeit prescription drugs are illegal, generally unsafe, and pose a serious threat

to the public health. Many are visually indistinguishable from authentic drugs." According to the Pharmaceutical Security Institute, the number of incidents involving drug counterfeiting rose 27% from 2004 to 2005, while the number of products affected rose 25% and the number of countries involved increased 17%. Domestically, the FDA issues safety regulations and must approve all products before they may be placed on the market. Consistency and reputation are critical in the commercial industry, therefore tolerance levels are minimized. However, illicit manufacturers operate under a different set of standards. Economics, risk, and availability of components determine the characteristics of these products. This presentation will address factors of production that may be valuable in distinguishing illicitly produced tablets.

There are many phases in the production of compressed tablets, all of which must work in unison to create an effective product. A comprehensive, detailed presentation will be provided as a guide to those interested in the outcomes of the manufacturing process on the finished product. These concepts can then be applied to improve drug analysis and intelligence investigations.

Drugs, Manufacturing, Tablets

B168 Comprehensive and Definitive Characterization of Drug Microcrystals

Roisin M. Cullinan, BSc, and Suzanne C. Bell, PhD, West Virginia University, Bennett Department of Chemistry, 217 Clark Hall, Morgantown, WV 26506*

After attending this presentation, attendees will learn the extent to which microcrystalline tests can aid in the identification of drugs of abuse. With it now possible to obtain structural data using XRD of the known microcrystals, drug samples can be identified using simpler analysis such as IR and Raman with the aid of the reliable libraries.

Based on the findings of the study, the scope for furthering microcrystalline tests in modern forensic laboratory has been highlighted. With a link between the drug sample and the microcrystal structure formed after reagent addition now recognized, this presentation will impact the forensic community and/or humanity by demonstrating how analysis such as mass spectrometry may no longer be necessary, with the growth of libraries in the future making analysis more efficient.

The aim of this study is to create a database of instrumental and visual characterization of microcrystals used in forensic analysis. The study utilized five reagents (PtCl₆, AuCl₄, AgNO₃, K₂CdI₄ and PbI₂-KOAc.), two of which are used in ASTM standard methods for microcrystal identification. The analysis and characterization of crystals was conducted using polarizing light microscopy, image recognition, infrared and Raman microspectroscopy, and X-Ray diffraction.

Central to this work was the definitive identification of crystal structures via the X-Ray diffraction studies. Previous work in here has shown the value of this approach as applied to GHB and related compounds. Here, work focused on much smaller crystals, specifically a group of related phenylethylamines (amphetamine, methamphetamine, phentermine, and ephedrine). Crystals were observed with several of the reagents and similarities and differences were noted. Structures of both the individual ion-pair unit structures and the aggregated crystal lattices were obtained. Most of the structures were hydrated and showed reproducible spatial arrangements. Variations in structures correlated as expected with differences in the heavy metal atom (Cd, Au, Pt, etc.). For example, amphetamine with gold chloride formed two independent molecular structural units within the crystal lattice, [NH₃ChMeCH₂Ph]•AuCl₄ with two water molecules. These units then organized themselves into a reproducible orthorhombic crystal.

These same crystals were also characterized using micro-FTIR using a diamond ATR cell and Raman microspectrometry at two wavelengths. Because these spectra were obtained from crystals of

known structures, reliable libraries can be created. Thus, forensic practitioners do not need X-Ray diffraction data to identify microcrystals but can rely now, in many cases, on secondary measurements such as IR, Raman, and micrographic measurements, to definitively associate a crystal structure with presence of a specific drug. In effect, a microcrystal test can be considered to be a chemical extraction technique. Thus, having a means of linking observed structure to identification moves microcrystal from presumptive and subjective to the realm of objective and definitive testing and significantly increases their value.

Microcrystals, X-Ray Diffraction, Phenylethylamines

B169 The Application of Single Crystal X-Ray Diffraction to Solve the Crystal Structure of the Complex Produced by the Gold (III) Chloride Microcrystal Test for Cocaine

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After attending this presentation, attendees will have gained an understanding of the crystal structure of cocaine and its gold (III) chloride complex, how this structure was determined using single crystal X-Ray diffraction techniques, and potential implications for the microcrystal testing of cocaine.

This presentation will impact the forensic community and/or humanity by demonstrating providing essential information regarding the molecular structure and interactions within the cocaine-gold chloride crystal.

The microcrystal test using chloroauric acid for the identification of cocaine has been used for over 120 years. Microcrystal testing is inexpensive and does not require sophisticated instrumentation beyond the light microscope. However, microcrystal testing has recently been criticized as being subjective and relying heavily upon the training and experience of the analyst. While the morphology and optical properties of the resulting crystals have been studied and documented, very little structural information has been available on the molecular level. Single crystal and powder X-Ray diffraction are ideal techniques for determining the chemical composition of crystals containing highly diffractive heavy metals, such as the cocaine-gold chloride complex.

Crystals suitable for single crystal X-Ray diffraction were grown very slowly at room temperature using evaporative concentration of a mixture of dilute aqueous cocaine hydrochloride and dilute acidified gold (III) chloride reagent. The resulting crystals were elongated gold colored parallelepiped rods.

The unit cell consists of a one to one ratio of four protonated cocaine ions and four anions of gold (III) chloride (AuCl_4^{-1}). The orthorhombic cell dimensions are $a = 7.7358(3) \text{ \AA}$, $b = 9.4543(5) \text{ \AA}$, and $c = 29.9093(13) \text{ \AA}$ [the numbers in parentheses are the errors in the last significant digits].

Several interesting features of the crystal structure are noted. One hydrogen bond and two close contacts exist, as shown by the X-Ray crystal structure. There is an intermolecular hydrogen bond between the hydrogen of the amine and the carbonyl oxygen of the benzoyl ester; a C-H...O close contact exists between the hydrogen of a methyl carbon and the methoxy oxygen in an adjacent molecule, and an intermolecular C-H...O close contact between a hydrogen of the phenyl ring and the methoxy oxygen. The crystal structure of the cocaine-gold chloride complex has been compared to the crystal structure of cocaine hydrochloride solved by Gabe and Barnes in 1963 and re-determined by Zhu et al. in 1999. In contrast, the crystal structure of cocaine

hydrochloride exhibits hydrogen bonding between the hydrogen of the protonated nitrogen atom and the chloride ion and a slightly weaker H-bond between the same protonated nitrogen atom and the methoxy oxygen atom. Additionally, the gold chloride anion, which is planar in many structures, was found to be quite flexed in this one, with two opposing chlorides being 0.078 \AA above the plane and the other two opposing chlorides being -0.081 \AA below the plane.

Following ASTM 1968-98, the microcrystal test was performed on pure cocaine hydrochloride. The resulting crystal precipitate was filtered and dried before the powder X-Ray diffraction pattern was obtained. The powder diffraction pattern of the microcrystals was compared to the electronically-generated pattern obtained from the single crystal structure in order to confirm that the crystals were identical.

The purpose of this research is to gain an understanding of how the structure of the cocaine hydrochloride and its gold (III) chloride complex may play a role in the formation of crystals visualized by the traditional microcrystal test. This is an ongoing research project at Rutgers University with the cooperation of the New Jersey State Police Office of Forensic Sciences. Further crystallographic studies will focus on other related drug compounds and their respective microcrystal tests.

Cocaine, X-Ray Crystallography, Microcrystal Tests

B170 Analysis of Adulterated Phenethylamines Using Capillary Zone Electrophoresis

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After attending this presentation, attendees will be introduced to a simple methodology using capillary zone electrophoresis for the quantitation of several phenethylamines, followed by chiral determination. The attendees will also become familiar with some of the limitations associated with this methodology.

This presentation will impact the forensic community and/or humanity by describing a simple and rapid technique utilized to quantitate several phenethylamines in the presence of common adulterants/by-products found in routine illicit samples. Furthermore, with the simple addition of a chiral selector, the chirality of the phenethylamine can be determined.

A simple, rapid, and robust method for the quantitation of phenethylamine analogs using capillary zone electrophoresis (CZE) was developed. Among the more well known analogs in this family are amphetamine, methamphetamine, and 3, 4-methylenedioxyamphetamine. These compounds are most often produced in clandestine laboratories by a variety of synthetic methods using easily obtainable precursors. Illicit samples often consist of complex mixtures multi-drug, precursors and by-products. Capillary electrophoresis provides an attractive alternative method to traditional high pressure liquid chromatography (HPLC) and gas chromatography (GC) methods that permits direct analysis of aqueous samples without the need for extraction or the use of organic solvents. The use of aqueous buffers reduces analysis cost and allows for simple disposal of waste solutions. Because neutral compounds migrate at the rate comparable to the electroosmotic flow (EOF), while the negatively charged acidic compounds migrate at a rate slower than the EOF, these species are not detected by CZE. Therefore, adulterants such as caffeine or acetaminophen do not interfere with quantitation by CZE. For example, when quantitating a tablet containing 30 mg of pseudoephedrine HCl with 500 mg of acetaminophen, because the latter migrates at a slow rate, it is not detected in the time range of analysis and is flushed from the capillary at the end of analysis. On the contrary, the

same analysis by HPLC or GC results in column overload that negatively impacts the chromatography and quantitation. Moreover, capillary zone electrophoresis offers the advantages of being capable of analyzing samples over a broad pH range, avoiding potential problems with thermally labile substances, and is also relatively inexpensive.

The current method utilized is capable of resolving complex mixtures commonly encountered in routine illicit drug analyses. The method described here uses a 34 cm x 50 μ m uncoated capillary, 100 mM lithium phosphate buffer at pH 2.3, with an applied voltage of 14.5 kV, and with thiamine HCl as the internal standard. The system was validated by demonstrating that each of the analytes' responses was reproducible and linear within a broad range of concentrations, and recovery values were accurate. Various capillary lengths were used to determine the selectivity of target compounds in the presence of common adulterants/by-products found in routine illicit samples.

The determination of the enantiomeric form is required in some cases for Federal sentencing guidelines as well as for intelligence purposes. Hence, a method for chiral separation by CZE was utilized. Figure 1 shows the chiral separation of amphetamine, methamphetamine, MDA, MDMA and MDEA on a 34 cm capillary using the same instrumental parameters mentioned above, but adding 20 mM 2-hydroxypropyl-beta-cyclodextrin to the lithium phosphate buffer as the chiral selector. All enantiomers for the standards were resolved. Hence, when the same methodology was utilized on actual samples virtually all methamphetamine samples analyzed were concluded to be the optically pure d form. In one case originating from Saipan, various proportions of l- and d-methamphetamine were present, which suggested that differing amounts of optically pure products having opposite isomers were mixed post synthetically.

The current study demonstrates that CZE performed on 34 cm uncoated capillaries using 100 mM lithium phosphate buffer is an effective technique for the quantitation of phenethylamine analogs. Quantitative results are all accurate, reproducible, and precise. The use of thiamine HCl as the internal standard was convenient, did not interfere with any known controlled substance or adulterant, and was commercially available at low cost. Chiral separation is conveniently accomplished on the same system with the addition of 2-hydroxypropyl-beta-cyclodextrin to the buffer. This simple methodology enables a laboratory to easily prepare all solvents and buffers in-house and to analyze a broad range of small molecules. This methodology has been used to quantitate hundreds of seized exhibits over the last three years, many of which were subsequently verified by other chromatographic techniques.

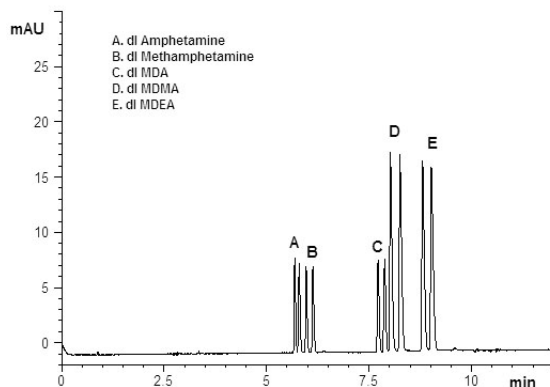


Figure 1: Separation of five phenethylamine racemic pairs on a 34 cm capillary. Background electrolyte consists of 100 mM lithium phosphate buffer containing 20 mM 2-hydroxypropyl- β -cyclodextrin as the chiral selector.

Forensic Science, Capillary Electrophoresis, Phenethylamine

B171 The Use of Electrospray Ionization - Mass Spectrometry for the Identification of Controlled Substances

Erin Nelis, BS*, Gerald M. LaPorte, MSFS, and Yvette Thomas, MFS, U.S. Secret Service, Forensic Services Division, 950 H Street NW, Washington, DC 20223

After attending this presentation, attendees will understand the principles of electrospray ionization – mass spectrometry (ESI-MS) and how this analytical technique can be used for the analysis of some common controlled substances such as cocaine, heroin, phencyclidine, methamphetamine, 3,4-methylenedioxymethamphetamine (MDMA), and 3,4-methylenedioxyamphetamine (MDA).

This presentation will impact the forensic community and/or humanity by demonstrating an additional analytical technique that may be used to identify controlled substances. The method is very fast, typically taking approximately 2-3 minutes for analysis.

Atmospheric pressure ionization mass spectrometry (API-MS) is an analytical detection method used for samples in the liquid phase and is typically interfaced with an instrument capable of separating chemical mixtures, such as a high pressure liquid chromatograph (HPLC). The basic caveats of mass spectral analysis require a sample to be ionized, analyzed via the mass charge ratio, and detected. Ionization, or the charging of molecules, can be accomplished using different modes such as ESI, which is a soft ionization process whereby a low voltage electrical field creates a series of charged droplets via nebulization. This procedure allows for the analyst to by-pass the traditional separation stage (i.e., liquid chromatography), and directly inject the sample into the MS. The resulting data is a series of spectra that provides composite information. Since the ionization is a “soft” process, spectral data should be easily interpreted with regards to major constituents.

The results from extensive developments of the method and protocol will be presented. The presentation will report on the advantages and disadvantages of the practical usage of this relatively new technique and the possibility of using it for quantitative analysis as well.

Electrosprayionization, ESI-MS, Controlled Substances

B172 Recent Advances in Liquid Phase Separations for MDMA Profiling

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After attending this presentation, attendees will better understand the utility of liquid phase separations including high performance liquid chromatography (HPLC), ultra performance liquid chromatography (UPLCTM), and capillary electrophoresis (CE) for the profiling of MDMA samples.

This presentation will impact the forensic community and/or humanity by assisting the forensic community by providing potential new tools for law enforcement for the analysis of illicit drugs.

Liquid phase separations allow the selective and/or sensitive determination of synthetic impurities, inorganic anions, and sugars in MDMA samples without prior extraction and/or derivatization. The high loadability of HPLC separations, coupled with selective and highly sensitive fluorescence detection, allows for the profiling of MDMA HCl samples even at purities as high as 98%. The presence of the methylenedioxy moiety on the benzene ring of MDMA and synthetic impurities gives rise to an approximate 75X increase in signal-to-noise

when using fluorescence detection versus UV detection. The comparison of profiles is facilitated by the use of isoexcitation and emission plots. These colored “3D” diagrams give snapshots of time, wavelength, and either excitation or emission intensity. The profile comparisons are aided by the use of a complementary CE screen for inorganic anions and sugars. Tablets with similar physical characteristics can exhibit similar fluorescence and anion profiles potentially indicating common synthetic origin and tableting material. Conversely, tablets with similar physical characteristics may also exhibit distinctly different anion and/or fluorescence profiles, indicating different tableting materials or different synthetic origin. Similarly, powders with comparable MDMA HCl content can exhibit different fluorescence profiles, indicating different synthetic origin.

Due to the lower particle size columns (1.7 μm), high pressure capability (≤ 15000 psi), and reduced dead volumes, UPLCTM affords higher peak capacity and lower separation times than conventional HPLC operating at ≤ 6000 psi. For MDMA profiling using photo diode array (PDA) UV detection, UPLCTM provides approximately twice the peak capacity of HPLC in approximately half the analysis time. UPLCTM, in combination with highly selective tandem MS detection, provides up to a 260X increase in signal-to-noise over PDA UV detection. This is accomplished using multiple reaction monitoring (MRM), where specific parent daughter combinations are monitored in the static mode.

MDMA, Profiling, Liquid Phase Separations

B173 Utilization of Purge and Trap-GC-MS to Analyze GHB, GHV, GVL, and GBL in Beverages

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The goal of this presentation is to discuss the investigation of purge and trap gas chromatography-mass spectrometry (PT GC-MS) as a quick and sensitive method for the detection of gamma-hydroxybutyrate (GHB), gamma-hydroxyvalerate (GHV), and their respective analogs, gamma-butyrolactone (GBL) and gamma-valerolactone (GVL), in complex matrices such as beverages. Attendees will become familiar with this application of PT GC-MS and how the different matrices affect detection capabilities.

This presentation will impact the forensic community and/or humanity by providing a physical method of detection for the highly controlled drug GHB, uncontrolled drug GHV, and their precursors GBL and GVL in beverages. This technique may be a potential tool for other polar drug molecules in similar matrices.

GHB and its lactone, GBL, have been a wide spread drug of abuse since the 1980's. Originally available over the counter, GHB was used for its euphoric, sedative, and anabolic effects. As with many central nervous system depressants, dependency syndrome can occur with prolonged use. Co-consumption of GHB with other drugs such as ethanol or methamphetamine increases the level of toxicity and can lead to death. The United States of America's National Institute of Drug Abuse classifies GHB as a controlled substance. Date-rape and other sex crimes often involve GHB due to its colorless, odorless properties, and its high solubility in drinks. Accurate detection from urine can be difficult due to rapid metabolism and excretion. Chemical analysis of hair can also indicate the presence of such drugs, but only months after administration.

Many of the chemical and physical properties of GHV and its precursor GVL are similar to GHB. To have the same toxicity and lethality, GHV has to be taken in higher dosages. Due to the fact that

GHV is not classified as a controlled substance and is readily available on many websites, drug abusers may be more prone to use GHV over GHB. GHV has a longer duration of action when ingested, and can also be used as a date rape-drug.

Since GHB and GHV are small, polar molecules, efficient extraction from polar solvents, such as drinks, is challenging. Physical separation can be done by a change in volatility. Using purge and trap, the molecules can be driven out of the liquid phase into the head space. The trap absorbs molecules from the headspace which allows the analytes to be concentrated before being sent to the GC-MS.

The GC was operated in a 5:1 split ratio mode with an injector port temperature of 250°C. The carrier gas (helium) flow rate was set at 1.5 mL/min. An initial oven temperature of 50°C was ramped at 25°C/min to 235°C followed by a 20 minute hold. A solvent delay of 0.10 minute was employed and total analysis time was 27.90 minutes. The column used in this experiment was a thick film (60m x 0.320 mm i.d, 1.80 μm) column was used for chromatographic analysis.

Purge and Trap, GC-MS, GHB

B174 Forensic Chemistry Analysis of Edible Goods Containing delta-9-Tetrahydrocannabinol (d9-THC)

Sandra E. Rodriguez-Cruz, PhD, U.S. Drug Enforcement Administration, Southwest Laboratory, 2815 Scott Street, Vista, CA 92081*

After attending this presentation, attendees will understand how to employ multiple physical techniques and instrumentation for the analysis of uncommon items containing the hallucinogenic component delta-9-THC.

This presentation will impact the forensic community and/or humanity by providing background and useful analysis information for analysts encountering rare exhibits classified as “medical marijuana.”

Recently, the Drug Enforcement Administration Southwest Laboratory (SFL-8) has been receiving numerous exhibits originated during the seizure of medical marijuana establishments throughout the state of California. These exhibits are usually labeled as containing hemp, weed, grass, cannabis, or THC and are usually obtained in the form of food products like cookies, chocolate bars, juice, muffins, caramels, lollipops, etc. These items have not been commonly encountered in the past. Their recent appearance and subsequently necessary analysis have provided for the opportunity to apply multiple analytical techniques in order to provide a confirmatory identification of the hallucinogenic ingredient.

This presentation will include experimental details of the extraction and solution chemistry procedures employed for the analysis of these edible goods and the isolation of the compounds of interest, usually delta-9-tetrahydrocannabinol. Results from the combination of multiple instrumental techniques will also be included and discussed. Numerous photos of these interesting exhibits will also be presented.

Identification of the hallucinogenic component delta-9-tetrahydrocannabinol has been possible using a combination of analytical techniques. Analysis of these food products has involved the development of various solid phase and liquid phase extraction methods as well as the development of a preliminary quantification procedure. The variable content of the exhibits has presented multiple experimental and instrumental difficulties. These subjects will also be addressed during the presentation.

Some of the food items received have been amenable to microscopic examination, and the presence of cystolithic hairs has been determined. The application of the Duquenois-Levine color test has also been investigated. However, the different physical characteristics and chemical composition of the various food items have made its use

somewhat limited. The concentration of delta-9-tetrahydrocannabinol in these exhibits has also been a limiting factor during analysis. Organic solvent extracts have been analyzed using thin layer chromatography (TLC), gas chromatography with flame ionization detection (GC-FID), and gas chromatography with mass spectrometry detection (GC-MS). Acidic extracts have also been analyzed using liquid chromatography – mass spectrometry techniques (LC-MS) employing electrospray ionization (ESI) and atmospheric pressure chemical ionization (APCI) interface sources.

For a limited number of these exhibits, analysis has also been possible using the newly developed technique of desorption electrospray ionization mass spectrometry (DESI-MS). This type of analysis has provided for a rapid identification of the active component (d-9-THC) without the need for extensive sample preparation and derivatization steps.

The combination of the various experimental procedures and instrumental techniques has made possible the confirmatory identification of delta-9-THC in most, if not all of the edible goods encountered to date. The techniques and methodology presented should be of interest to the criminalistics audience, especially those analysts involved in the analysis of “medicinal” marijuana items. The presentation will also illustrate and emphasize the importance and complementary nature of the multiple instrumentation techniques available to forensic chemists today.

Forensic Chemistry, delta-9-Tetrahydrocannabinol, Cannabis

B175 High Efficiency DNA Extraction From Bone by Total Demineralization

Odile M. Loreille, PhD, Toni M. Diegoli, MFS, Jodi A. Irwin, MS, and Michael D. Coble, PhD, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Rockville, MD 20850; and Thomas J. Parsons, PhD, International Commission on Missing Persons, Alipašina 45a, Sarajevo, 71000, Bosnia and Herzegovina*

After attending this presentation, attendees will learn about bone extraction and how to get better STR profiles from bones.

This presentation will impact the forensic community and/or humanity by demonstrating how this new demineralization protocol can significantly enhance the quantity and quality of DNA extracted from degraded skeletal remains. This technique has great potential to recover authentic DNA sequences from extremely challenging samples that repeatedly failed when using the standard forensic protocol.

In historical cases, missing persons' identification, mass disasters, and ancient DNA investigations, bone and teeth samples are often the only, and almost always the best, biological material available for DNA typing. This is because of the physical and chemical barrier that the protein:mineral matrix of bone poses to environmental deterioration and biological attack. DNA is generally best preserved in dense cortical bone, and a recent study indicates that very high quality DNA may be locked away in small, extremely dense crystalline aggregates that are highly resistant to chemical infusion (Salamon et al). Evidence and reason both suggest, then, that the most abundant and best preserved DNA in bone is also the most difficult to access and extract.

Most bone extraction protocols utilized in the forensic community involve an incubation period of bone powder in extraction buffer for digestion, followed by the collection of the supernatant, and the disposal of large quantities of undigested bone powder (and unextracted DNA). Alternatively, some bone extraction methods utilize high volume EDTA washes to partly or completely demineralize the bone, resulting in more complete digestion of the bone powder. That DNA is also liberated, and discarded, during the washing step has been demonstrated.

Presented here is an extremely efficient means for recovery of DNA by full demineralization, resulting in full physical digestion of the bone sample. This is performed in a manner that retains and concentrates all the reagent volume, so that released DNA is recovered.

Fifteen bone fragments were extracted side-by-side with this new demineralization protocol and the standard extraction protocol in use at AFDIL. A real-time quantification assay based on the amplification of a 143bp mtDNA fragment showed that this new demineralization protocol significantly enhances the quantity of DNA that can be extracted and amplified from degraded skeletal remains. This technique has been used to successfully recover authentic DNA sequences from extremely challenging samples that failed repeatedly using the standard protocol. The better preserved samples were tested for STR analysis and the number of loci characterized almost doubled between this demineralization extract and the standard extract.

Reference:

Salamon M, T. N., Arensburg B, Weiner S, (2005). “Relatively well preserved DNA is present in the crystal aggregates of fossil bones.” *Proc Natl Acad Sci U S A*. 102(39): 13783-8.

Bone, STR, Demineralization

B176 Polymerase Resistance to PCR Inhibitors in Bone

Ken D. Eilert, BS, and David R. Foran, PhD, Forensic Science Program, Michigan State University, 560 Baker Hall, East Lansing, MI 48824*

After attending this presentation, attendees will understand the utility of different DNA polymerases for amplifying difficult or inhibited DNA from skeletal material.

This presentation will impact the forensic community and/or humanity by surveying a series of commercially available DNA polymerases for their capability to facilitate PCR in the presence of elements co-extracted during phenol-chloroform extractions of recent and aged forensic bone specimens. Greater success in DNA typing from bone should result.

This presentation outlines the results of a three-part study intended to 1) use mass spectrometry to identify and quantify the major co-extracted inhibitory elements in recent versus aged/damaged bones, 2) target polymerase weakness and resistance by stressing a series of selected polymerases with increasing levels of the identified inhibitors and 3) determine the most resistant polymerase by stressing the enzymes with varying concentrations of whole bone extract.

Successful recovery of DNA from poor quality bone samples necessitates optimization of the polymerase chain reaction. This includes the ideal concentrations of thermostable polymerase, template DNA, free nucleotides, Mg²⁺, and buffering salts. The reaction environment must permit the appropriate interaction of polymerase with template DNA. Any substance present in the PCR reaction that interferes with this interaction is categorized as an inhibitor.

Many agents of inhibition in bone have been identified, though the exact mechanisms of inhibition remain unclear. Type I collagen has been shown to be a potent inhibitor of PCR and likely co-extracts with DNA during the extraction process. Additionally, bones left in contact with soil can accumulate humic and fulvic acids, which have also been proven inhibitory. The presence and concentration of endogenous and exogenous inhibitors varies as to the circumstantial history of the received sample.

The study attempts to utilize MALDI-TOF and ICP-MS to identify and quantify possible inhibitory elements found in the DNA extractions of both fresh and aged bone samples. Determining these elements allows for a targeted polymerase inhibitor resistance assay. Because the phenol-chloroform method of extraction is standard for bone sample amplification, the study focuses on products obtained by this technique.

The inhibitor resistance assay tests several polymerases for their amplification capability in the presence of the identified inhibitory elements. PCR reactions are designed to amplify human mtDNA stretches HVI and HVII. Each polymerase is stressed with increasing

concentrations of the individual inhibitors as well as concentrations of whole bone extractions. Challenging bone sample extracts recovered by the phenol-chloroform method often require considerable dilution before inhibition is relieved. This dilution factor is used to determine efficacy of the polymerases exposed to whole bone extract.

DNA Polymerase, Skeletal DNA, PCR Inhibition

B177 Microscopic Groupings of Hairs as a Basis of Sample Selection for DNA Testing: Feasibility and Examples

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After attending this presentation, attendees will have learned how microscopic groupings of hairs can be used as a basis for sample selection for DNA testing. Examples using both photomicrographs and written descriptions will be presented to assist the listener in understanding how the hairs are sorted into groups. This presentation will demonstrate that evidence hairs, i.e. unknowns, can be intercompared to form groups or sub-sets, that the groups form a valid basis for sample selection for DNA testing, and that such groupings permit sample selection to be based upon potential significance rather than simply whether the hairs are likely to yield results. This offers a way to control for errors introduced by a DNA-only analytical approach.

This presentation will impact the forensic community and/or humanity by demonstrating how incorporating microscopic groupings as a basis for DNA testing of hairs should lead to a reduction in errors introduced into hair evidence by a DNA-only approach and to a reduction in bias inherent in targeted microscopic searches for hairs that may be from a specific suspect among hairs from a victim's person and belongings.

Before DNA testing could be routinely applied to human hair examination, it was not possible to link a hair with a specific individual unless reference samples from that individual were available. Hairs from the arms, legs, eyebrows, eyelashes and so on were not usually suitable for a complete comparison. The conclusions from microscopic hair comparison were not highly specific, and because the quality of work was uneven from laboratory to laboratory and even from examiner to examiner, errors arose that prompted concerns about the reliability of the method. Many examiners reached conclusions from subjective impressions instead of objective data. Adequate training was lengthy and comparisons were time-intensive.

An objective, reliable and highly specific method that could be applied to hairs from any somatic (body area) region became available when it became possible to test hair roots via DNA analysis and use data base searches as an investigative tool if no reference samples were available. However, only hairs with anagen (actively growing) roots could be expected to routinely yield results. Because most evidence hairs are shed rather than forcibly removed, this method could not be successfully applied to most hairs, nor could it be applied to hairs that broke off without the root. This limitation was partly overcome when hair shafts could be tested for mitochondrial DNA, but with new limitations: mitochondrial DNA is not as specific as nuclear DNA, and barring mutations, does not distinguish among relatives in the maternal line, however far removed they may be. Data base searches are not yet possible. Because the hair must be crushed to extract the DNA, any microscopic information is lost during sample preparation, and if the results are inconclusive, microscopic analysis would no longer be possible.

Despite the limitations of microscopic hair comparison, microscopic examination can provide many types of information that DNA testing does not: somatic (body area) origin, the growth stage of the hair root and any putrefaction; adhering debris, and whether the hair itself is likely to be older debris; chemical treatment and mechanical damage; decomposition and insect damage; and so on. These types of information can provide a time line for the hair deposit and assist in determining its significance. The examinations can be performed even if the microscopist does not have extensive training in morphology-based hair comparison. The value of microscopy is well recognized for these types of examinations.

Less recognized is a more urgent analytical problem: the selection of samples for DNA testing. Since it is seldom possible with current technology to test every hair via DNA analysis, selection of adequate samples is crucial. Significant error can arise from sampling, so that even if the DNA results are accurate, any interpretation of significance may be skewed if the basis for selecting hairs is faulty. Unless a skillful microscopic examination is performed first, the current basis for sample selection is the suitability of the hairs for testing. In other words, the testing determines the sample selection instead of the other way around. Testing – of any kind - should be performed on samples selected for their potential value as evidence. If hairs from several different individuals are represented on an item of evidence, the sampling process should ensure that at least one hair from each person be sampled, and that the somatic origin be considered.

The idea of using sub-sets, or groupings, of hair as a basis for selecting samples for DNA testing was presented by one of the authors at a previous AAFS meeting. Actual examples of such groupings using photomicrographs and written descriptions will be presented. It is not necessary to compare each hair directly with each other hair if the descriptions are adequate, although it is useful to intercompare some of the hairs as a cross-check. The sampling error described above can be obviated by performing a microscopic grouping of hairs from an evidence item, using the same morphological features that would be used for a formal microscopic comparison. Instead of comparing the evidence hairs with reference samples, the evidence hairs would be grouped into sets via an intercomparison of unknowns.

Microscopic grouping and testing of a hair from each group would not be necessary if searching for hairs that may be from a victim on the clothing or person of a suspect, in which case it would be better to perform a comparison with reference samples from a victim. Only hairs that can link the suspect to the crime would be significant, and unless sets of debris are being compared, in most cases this would be the victim's hairs. However, the common practice of searching among hairs collected from a victim's person and belongings for hairs microscopically similar to those of a suspect introduces a bias that the suspect is the perpetrator. Microscopic grouping of hairs eliminates this bias and provides a more neutral sampling method of testing the evidence hairs.

Reported is the feasibility of training someone with no prior experience in human hair comparison to perform such groupings. A weeklong training class followed by feedback from experienced examiners would allow examiners who are not primarily hair examiners to sort the hairs into groups but not perform final microscopic comparisons. If no experienced hair examiner is on site, the person being trained can use DNA results of groupings performed on in-house proficiency samples for feedback. Training in either case should incorporate the use of DNA results to test whether grouping criteria are valid. It is to be expected that more than one grouping can be attributed to a single individual. However, if a single grouping includes hairs that can be attributed to more than one individual; the grouping criteria should be reevaluated.

Abandonment of traditional microscopic hair comparisons using reference samples is not recommended. However, with a combination

of microscopic groupings followed by DNA analysis of one hair from each group, it is no longer necessary to perform complete microscopic comparisons on every case where hairs may be significant evidence. A smaller number of laboratories nationwide that continue to perform rigorous microscopic comparisons should be able to perform this service for other laboratories in those cases where nuclear DNA testing is not feasible, much as is currently done for mitochondrial DNA testing. For example, microscopic hair comparison should be performed in cases where it is important to distinguish among maternally related family members not distinguishable by mitochondrial DNA, and if there is only a single hair in a microscopically determined group, since mitochondrial DNA testing requires destruction of the hair shaft.

In summary, a combination of microscopic grouping and DNA testing of hairs from each group should allow most cases involving hairs to be examined without compromising cases with the errors that a DNA-only approach introduces, yet without using the more time-consuming formal microscopic comparisons. Fewer laboratories should need to train examiners in more rigorous microscopic hair comparisons, and regional centers or other designated laboratories should be able to handle the microscopic comparisons that will still be needed.

Forensic Science, Hair, DNA Testing

B178 Methods for the Assessment of the Suitability of Catagen Hairs for Nuclear DNA Profiling Using Nuclear Fast Red Staining and Polarized Light Microscopy

Jennifer A. Sampson, BS, Daniele Podine, DBiol, and Walter F. Rowe, PhD, Department of Forensic Sciences, The George Washington University, Washington, DC 20052*

After attending this presentation, attendees will learn how to use Fast Nuclear Red stain and polarized light microscopy to assess the suitability of hair roots for PCR amplification for nuclear STR analysis.

This presentation will impact the forensic community and/or humanity by making the forensic community aware of simple assessment techniques for determining the suitability of a hair root for the nuclear STR analysis.

Hairs may be found at crime scenes and can provide useful identifying information. While mitochondrial DNA is commonly extracted from hairs, nuclear DNA can also be available for short-tandem repeat (STR) analysis. STR analysis is forensically more informative than mitochondrial DNA sequencing and therefore should be done if possible. Not all evidentiary hairs are suitable for the recovery of nuclear DNA. Sufficient nuclear DNA for STR analysis can be obtained from an actively growing anagen hair root. On the other hand, telogen hairs lack growing cells and sufficient nuclear DNA for STR analysis may not be recovered from them. Catagen hairs are those hairs that are in the process of switching from the actively growing anagen phase to the fully keratinized telogen phase. It would be useful for the forensic molecular biologist to be able to determine if a catagen hair is likely to yield sufficient nuclear DNA for STR analysis. Two approaches for assessing a catagen hair root's suitability for STR analysis were explored: polarized light microscopy (PLM) and staining with Nuclear Fast Red stain. In the catagen phase of hair growth progressive keratinization of the root bulb results in an increase in the retardation of plane polarized light so that the interference colors observed with PLM should be indicative of how close the hair root is to the telogen phase. On the other hand, staining with Nuclear Fast Red stain (the first stain in the 'Christmas Tree' staining procedure frequently used in the microscopical identification of spermatozoa) should disclose the presence of cell nuclei in the root tissue of a catagen hair. Nuclear Fast Red staining does not interfere with subsequent STR analysis.

Plucked hair samples were obtained from a male donor. Those hairs lacking readily observable follicular tissue were subjected to Nuclear Fast Red staining by immersing the roots for several minutes in the staining solution. The hairs were removed from the staining solution and rinsed with distilled, deionized water. The hair roots were then temporarily mounted on microscope slides in distilled, deionized water. The hair roots were photographed under normal transmitted light and between crossed polarizing filters.

DNA was isolated using an organic extraction and quantitated with a Real-Time PCR assay for nuclear autosomal DNA. The results indicated a correlation between the intensity of Nuclear Fast Red staining and the amount of DNA that could be extracted from the hair root. To facilitate the interpretation of the Real-Time PCR assay the stained roots were grouped in four categories defined by the amount and intensity of Nuclear Fast Red staining: (a) no visible staining of the follicle; (b) slight staining (thin area around the hair root with a pink/light red color); (c) clear and well defined staining around the hair root; and (d) a thick dark red stained area around the hair root. These four categories showed consistent results in DNA concentrations, yielding respectively (a) less than 0.01 ngm/ μ L, (b) between 0.01 ngm/ μ L and 0.09 ngm/ μ L, (c) between 0.1 ngm/ μ L and 0.5 ngm/ μ L, and (d) more than 0.5 ngm/ μ L. PLM did not yield any clear-cut categories. Evidently the process of root keratinization does not correlate closely with the quantity of actively growing cells attached to the root.

The data obtained suggest that observing the quantity/intensity of the staining of hair root treated with Nuclear Fast Red stain can allow the forensic molecular biologist to predict the amount of nuclear DNA that can be extracted and amplified from the sample. This technique could be applied as an initial screening tool for hair samples classified as catagen hairs and allow DNA laboratories to optimize their resources by ruling out samples with very low likelihood of yielding sufficient nuclear DNA for an STR profile. Samples that are determined to be unlikely to yield an STR profile can be submitted for mitochondrial DNA sequencing.

Hairs, Real-Time PCR, DNA

B179 Examination of Methods for Amplification of Nuclear DNA From Human Telogen Hairs

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After attending this presentation, attendees will gain an understanding of the processes of obtaining a genetic profile from single telogen hairs using reduced-size STR primer sets.

This presentation will impact the forensic community and/or humanity by providing information on the methodology required for obtaining genetic profiles from single human telogen hairs collected as evidence as well as the likelihood of producing a profile from these types of samples.

Shed telogen hairs can be an important form of forensic evidence. Such samples are usually reserved for mtDNA analysis due to the assumption that little nuclear DNA is present. Unfortunately due to its small size and haploid nature, mtDNA lacks the probative value of nuclear DNA. Since telogen hairs are not expected to contain much nuclear DNA, such samples are reserved for mtDNA testing or are not amplified and typed. Few studies have probed the absolute amounts of nuclear DNA in hair. This was due to a lack of a suitable quantitative technique to analyze such samples. In spite of this problem, several studies have been published on the extraction and amplification of DNA

from hair. While some success has been reported for amplification of DNA from hair, accurate quantification of the extracted DNA has been a problem. Before the use of real time PCR for quantification, DNA analysts have relied on methods which lack the sensitivity required to detect the minute amounts of DNA found in hair. Therefore, information on the actual amount of nuclear DNA that can be recovered from hair is scarce.

In a previous study, after sampling over 500 individual hairs, it was determined that the majority of subjects (70%) had on average less than 500 pg of total recoverable DNA per hair. In addition, through the use of different size *Alu* primers and real time quantitative PCR, it was demonstrated that the DNA extracted from telogen hairs is highly degraded. Both of these conditions present a problem for obtain a genetic profile from shed telogen hair evidence. Additionally, PCR inhibitors such as melanin which may be present in hair can interfere with the amplification and reduce the possibility of obtaining a DNA profile. In the case of low amounts of DNA, dilution or purification methods such as sodium hydroxide or silica based spin columns, which typically result in a loss of DNA, are not feasible for these types of samples.

In this study, the focus was on the methods required to produce a profile from nuclear DNA extracted from human telogen hairs using the Miniplex reduced-size STR primer sets. Concentration of samples and collection of samples in lower volumes were both evaluated as possible solutions to low concentrations produce in the original method. For new extractions, single hairs from different individuals were extracted using a protocol that included a differential extraction to remove exogenous DNA. Previously extracted samples were concentrated and collected in 10 μ L (instead of 60). The extracted DNA was quantified by real time PCR using an 82 bp *Alu* amplicon.

Because of the limited amounts of recoverable DNA present in the hair and due to its high degree of degradation, changes in several PCR reaction mix components were investigated. These included the concentration of primers and other PCR reagents as well as addition of various concentrations of bovine serum albumin (BSA) to relieve inhibition. Three ranges of extracted and quantified DNA were tested for amplification success: high (>500 pg), medium (100-500 pg) and low (< 100 pg). The high range samples were tested with all three Miniplexes sets while the lower level concentrations were amplified with a single set of reduced size amplicons. The results are discussed in terms of the potential compromises necessary when utilizing samples containing low levels of degraded DNA.

Reduced Size STRs, Degraded DNA, Human Telogen Hairs

B180 Is Specific Melanin Content in Human Hairs Related to Mitochondrial DNA Typing Success?

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After attending this presentation, attendees will understand the difference between the types of melanin within human hair, the potential role of melanin in the ability to successfully obtain mitochondrial DNA (mtDNA) sequence data, and the advantages that a preliminary microscopic examination of a hair may provide.

This presentation will impact the forensic community and/or humanity by demonstrating how this data may help determine if a preliminary microscopic examination of a hair prior to mtDNA analysis would serve as a way to gauge the potential for mtDNA success. This type of screening procedure based upon the biological features of a hair could potentially save time and money for the forensic DNA laboratory.

Hairs are the only structure in the human body that completely replace themselves by continuously cycling through three phases. Anagen is the growing phase of the hair that lasts several years. Catagen is the regression phase of the hair marked by termination of melanogenesis, mitosis, and growth. Telogen is the resting phase of the hair that precedes exogen during which apoptosis is complete and the root stem is fully keratinized. Most human head hairs found at crime scenes are in the telogen phase, often lacking follicular tissue, which makes them unsuitable for highly discriminating nuclear DNA (nDNA) analysis. Thus, it is often necessary for forensic analysts to turn to mitochondrial DNA extraction and analysis for these types of samples. Most hairs contain melanin – an organic polymer built from oxidative tyrosine derivatives. Melanin is synthesized in the elliptical or oval melanosome organelle. There are two types of melanin in hairs and skin: eumelanin and pheomelanin. Pheomelanin is the cysteine-rich red-yellow form while eumelanin is a less-soluble black-brown form. Eumelanin grains are the larger, denser particles and have been shown to protect nDNA from UV radiation through their supranuclear distribution in dermal keratinocytes. Eumelanosomes in hair shafts are wedged between keratin macrofibrils, next to the mitochondria, thus possibly affording photoprotection for mtDNA. Pheomelanin has been shown to be photosensitive and contribute to the degradation of nDNA and mtDNA in living cells after UV-visible light exposure. Eumelanin is predominately found in darker hairs (dark brown, black) while pheomelanin is predominately found in lighter hairs (red, blonde). This study will aim to determine if eumelanin protects mtDNA in the hair shaft from photodegradation as it does in skin. If this hypothesis is true, the predominate eumelanin dark brown hairs' mtDNA sequence would be expected to be more easily typed than mtDNA from photosensitive pheomelanin red hairs or gray hairs that lack pigmentation altogether.

Hairs were collected from three Caucasian groups: predominate eumelanin (dark brown), predominate pheomelanin (red), and no melanin (gray). From each donor, a hair was taken from the left and right sides of the scalp. The prescreened hairs that were selected for this experiment met a baseline diameter and length size for inclusion in the study, making the type of melanin present in the hair the only significant variable factor in determining mtDNA typing success. Reference donor samples were collected and used to compare to donor hair samples for sequence confirmation. Washed hair fragments that were 2 cm long, and cut at a location 5 cm away from the root, were ground using a microtissue grinder and DNA was extracted organically. HV1 primers F16140 and R16420 were used in amplification, product gels were run to gauge amplification success, and Rapid PCR Purification Systems were used for product cleanup. ABI BigDye® Terminator v.3.1 Cycle Sequencing Kit was used for cycle sequencing and DTR Gel Filtration Cartridges were used for cycle sequencing cleanup. Samples will be sequenced using the ABI 3100-Avant Genetic Analyzer with ABI Sequencing Software v.5.1.1 and Sequencher v. 4.7 used for analysis. Sequencing success will be measured by contiguous mtDNA sequence length in base pairs.

Product gels showed bands at the expected size of 281 bp for each hair sample and the positive control upon mtDNA PCR amplification. All reagent blanks were clear. Sequence data is being accumulated for analysis and will be presented and discussed. This data may help determine if a preliminary microscopic examination of a hair prior to mtDNA analysis serves as a way to gauge the potential for mtDNA success. This type of screening procedure based upon the biological features of a hair could potentially save time and money for the forensic DNA laboratory.

Hair Biology, Melanin, Mitochondrial DNA

B181 Analysis of Dye Terminator Sequence Data: Pattern Recognition and Signal Background

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After attending this presentation, attendees will understand procedures and processes for further analysis of sequence data; the attendee can learn other methods in evaluating sequence data.

This presentation will impact the forensic community and/or humanity through additional analysis tools for mitochondrial DNA sequencing results with increased base calling accuracy.

Mitochondrial DNA (mtDNA) sequence analysis is a technique that is well characterized, validated, and useful in the analysis of forensic evidence and identification of human remains. The technique has become more popular as a result of successes in identifying older skeletal remains and hair samples. Forensic laboratories sequence two regions within the D-loop of the mitochondrial DNA genome. These two regions within the D-loop's 1.1 Kb fragment can display multiple variations between individuals. The two variable regions, hypervariable region 1 (HV1) and hypervariable region 2 (HV2), are amplified, detected, and analyzed for forensic identification. It is common practice for forensic laboratories to report HV1 and HV2 sequence information. Unlike STR analysis where discrete alleles according to size are reported, mtDNA analysis reports the observed base sequence. The standard for the forensic community is to report the sequence information as compared to the revised Cambridge Reference Sequence's (rCRS) light strand. The scientists critically analyze each base of the evidentiary specimens and the reference samples in HV1 and HV2 and compare it to the rCRS. As mitochondrial DNA sequencing becomes more commonplace in the forensic laboratories, and as national databases are being used for identification purposes, accurate base calling is critical. Phenomena such as artifacts and noise in sequencing technology should be minimized and easily recognized by the trained analyst. Data quality must be sufficient to unambiguously call the reported base positions. Hence, mtDNA is sequenced in both the forward and reverse directions. An analyst must be experienced in recognizing confirmed quality sequence data, distinguishing single source versus mixed sequence data, and identifying heteroplasmy. The correct interpretation of mtDNA analysis is important.

Patterns in peak heights in local mitochondrial DNA sequencing frames from the D-loop will be presented. These patterns are quite easy to establish and allow for prediction modeling in local sequence frames. Identifying these patterns in local sequence frames from single-source samples can increase base calling accuracy. A single base change can affect the peak heights, or patterns, in these local sequence frames. Patterns in peak heights have previously been characterized (Zakeri et al., 1998) using dRhodamine and Big Dye™ terminator sequencing on a Model 377 DNA Sequencer. In summary, Zakeri et al. demonstrate that the peak height of a base 3' to one or two bases can be predicted using dRhodamine terminators and the peak height of a particular base can be predicted using BigDye™ terminators by knowing the local sequence frame. This study focuses on similar modeling techniques using today's higher throughput multicapillary ABI PRISM 31xx instrumentation, new dye terminator chemistries available today, and mitochondrial DNA sequence data only. This combination of chemistry and instrumentation is commonplace in the forensic mitochondrial DNA sequencing

laboratory. Multiple samples have been sequenced on the ABI PRISM 31xx using both dRhodamine dye and BigDye™ v.3.1 terminators. Trends are observed and will be described. These trends can be programmed and adopted in artificial intelligent computerized program systems. Peak patterns, frame patterns, and dye terminator effects can be characterized to improve the base-calling accuracy made by software programs and the forensic DNA analyst.

BigDye® Terminator, dRhodamine Dye Terminators, Sequencing

B182 Development and Expansion of High Quality Control Region Databases to Improve Forensic mtDNA Evidence Interpretation

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After attending this presentation, attendees will understand the current limitations of mtDNA population databases for forensic mtDNA casework involving criminal evidence and missing persons specimens. This presentation will explain the current efforts underway at the Armed Forces DNA Identification Laboratory (AFDIL) to increase both the size and quality of mitochondrial DNA control region population databases for the forensic community.

This presentation will impact the forensic community and/or humanity by demonstrating that large, high quality mtDNA databases can and should be established to maximize the benefit to forensic mtDNA applications in criminal casework and missing persons investigations.

Forensic mtDNA analysis of highly degraded materials, or samples lacking sufficient quantity of nuclear DNA for STR testing (e.g., shed hairs) has found an important niche in DNA testing. Once a mtDNA sequence haplotype is generated for a case sample, it is necessary to assess the significance of the evidence using an appropriate population database. Such an assessment is similar to the evaluation of Y-STR evidence. However, mtDNA databases are significantly more costly and time consuming to generate than Y-STR databases, and the strength of the mtDNA evidence is often dependent upon the size of the population database used for comparison. Therefore, a sufficiently large population sampling is required for forensic mtDNA databases.

Recently, phylogenetic analyses of published mtDNA databases have been utilized to identify sequencing "phantom mutations" and other artifactual errors in forensic databases.¹ A series of high profile discussions has taken place in the scientific literature debating the seriousness of these errors,^{2,3} culminating in a court case (US v. Ida Chase) that challenged the admissibility of the current forensic mtDNA database. Although the forensic mtDNA database was accepted in the resolution of this particular case, it is hoped that the current situation will be improved by developing high-quality mtDNA control region sequences for the forensic community.

AFDIL has developed a high-throughput automated system that utilizes robotic instrumentation for all laboratory steps from pre-extraction through sequence detection, and a rigorous 5-step, multi-laboratory data review process with entirely electronic data transfer. Since 2004 this laboratory has generated over 5000 control region sequences from both U.S. populations and underrepresented global populations (such as several from Central Asia).

The strength of this project is based on collaborations with colleagues, who provide the laboratory samples for sequencing and in return are provided co-authorship on any resulting publications. Furthermore, a strong relationship with the European DNA Profiling Group's was developed (EDNAP) Mitochondrial Population Database (EMPOP) team for additional quality control checking of the data and phylogenetic analyses. Additionally, EMPOP plans to provide these data to the forensic community.

Current progress on an effort being funded by the U.S. National Institute of Justice to generate over 3500 control region databases per year from U.S. populations will be presented. In addition to the high quality data generated from this effort, presented will be phylogenetic analyses of the data to determine the relative mutation rate of the control region. Some interesting nomenclature issues that have been encountered will be presented. Finally, some preliminary data that examines the substructure and heterogeneity of various regional or named population groups (such as "Hispanics") within the United States and component source populations will be given. In conclusion, large, high quality mtDNA databases can and should be established to maximize the benefit to forensic mtDNA applications in criminal casework and missing persons investigations.

References:

- ¹ Bandelt, HJ, Lahermo, P, Richards, M, Macaulay, V (2001) Detecting errors in mtDNA data by phylogenetic analysis. *Int J Legal Med.* 115(2):64-69.
- ² Bandelt, HJ, Salas, A, Bravi, C (2004) Problems in FBI mtDNA database. *Science.* 305(5689): 1402-1404.
- ³ Budowle, B, Polansky, D (2005) FBI mtDNA database: a cogent perspective. *Science.* 307(5711):845-847.

Mitochondrial DNA, Population Databases, Control Region

B183 Increasing Mitochondrial DNA Discrimination Using a Panel of 84 Immobilized SSO Probes Targeting Informative Sites Within the Mitochondrial Genome

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After attending this presentation, attendees will be introduced to a newly developed, highly sensitive multiplex PCR and LINEAR ARRAY assay used to detect sequence variation in the mitochondrial genome with a panel of 84 probes designed to increase the power of discrimination compared to the LINEAR ARRAY HVI/HVII assay as well as HVI/HVII sequencing.

This presentation will impact the forensic community and/or humanity by demonstrating how this newly developed assay will allow the practitioner an alternate method of typing mtDNA with increased discrimination power compared to current mtDNA HVI/HVII sequencing and typing methods.

Mitochondrial DNA, particularly the hypervariable regions I and II (HVI/II), has proven to be a useful target for the forensic genetic analysis of limited and/or highly degraded samples. However, there are some inherent limitations to targeting only the HVI and HVII regions independent of the method of analysis; the power of discrimination is limited for all population groups as a result of a few relatively common HVI/HVII sequences. Most notably seven percent of Caucasians share the same common HVI/II sequence (differing from the Anderson reference sequence at 263G) and 13 additional sequences are shared among >0.5% of the population. Also, several common sequences can be found among Hispanic individuals. Therefore to overcome the

limited power of discrimination, additional sequence polymorphisms in the variable and coding regions need to be targeted to increase the power of discrimination of mtDNA analysis.

To achieve this goal, additional polymorphic sites have been identified within the coding region as well as the HVII and Variable Regions (VR) of the mitochondrial genome that help further distinguish common HVI/HVII types. Primers and probes targeting these sites were designed to work under the existing amplification and typing parameters of the LINEAR ARRAY HVI/HVII mtDNA Sequence-Typing assay. Up to 53 probes will be added to the existing 31 HVI/HVII probe panel for a total of 84 probes. PCR products generated with a single multiplex PCR targeting the VR and coding region sites can be combined with PCR products generated with the HVI/HVII duplex PCR and can then be typed simultaneously with a panel of 84 probes immobilized on a nylon membrane. Once the samples are typed, the LINEAR ARRAY probe panels can then be scanned and typed using the newly developed StripScan Mitotyper 1.0 mtDNA typing software.

Additionally, results from a small population study will be reported here to illustrate the improved power of discrimination of the 84 probe panel assay compared to HVI/HVII mtDNA typing and sequencing. Preliminary results of a small Caucasian population study using the 56 probe panel indicate that the genetic diversity (h value) was increased from 0.973 with the HVI/HVII probe panel to 0.992 with the 56 probe panel, which is nearly as informative as the h value obtained with HVI/HVII sequencing (0.994). With the addition of 28 probes, the discrimination power of the 84 probe panel will be greater than that of HVI/HVII sequencing.

Mitochondrial DNA, Linear Array, Immobilized SSO Probes

B184 Forensic Application of the Affymetrix Human Mitochondrial Resequencing Array

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In the field of forensic DNA testing, coding region polymorphisms in the mitochondrial genome can be useful for resolving individuals who have the identical HV1 and HV2 control region sequence. Sequencing regions of the mitochondrial genome is performed when insufficient genomic DNA is present for traditional autosomal short tandem repeat (STR) testing. Various methods and strategies have been established to interrogate coding region polymorphisms. These range from SNP assays probing sites most likely to differentiate individuals based on their HVI/HVII sequence to the use of mass spectrometry to pyrosequencing. The goal of this presentation is to evaluate the potential of the Affymetrix GeneChip® Mitochondrial Resequencing Array (ver 2.0) for forensic applications.

This presentation will impact the forensic community and/or humanity by providing the forensic community with an evaluation of a array-based method for full genome mitochondrial sequencing. At this time the mitochondrial resequencing array method requires more input DNA in contrast to traditional sequencing or even STR analysis. However, the array may find utility in full genome sequencing of family reference samples.

The GeneChip® Mitochondrial Resequencing Array is a means to perform full genome sequencing on an array-based platform. The amount of DNA needed for the resequencing array is much greater than that required for autosomal DNA typing (1 ng versus 10-30 ng). Because of this relatively high sample requirement the array may have limitations for running a limited quantity of casework sample. However

the platform should have utility in running family reference samples for the elucidation of SNPs that will help resolve individuals. These array-determined polymorphisms found in reference sample can then be probed in the limited casework sample.

Materials and Methods: A set of 10 U.S. Caucasian samples found to contain the same control region sequence by traditional fluorescent sequencing were run on the GeneChip® platform. The reproducibility of GeneChip® experiments was evaluated by running samples in triplicate for two of the samples. A sensitivity study was also conducted in which a dilution series of 10 ng down to 0.3 ng of template DNA (nuclear) was amplified for the array experiments. Two challenging samples were also examined to test the array's ability to successfully call a relatively large number of sequence differences (46 and 63 respectively) compared to the revised Cambridge Reference Sequence. All results were compared to traditional dideoxy fluorescent full genome sequencing experiments.

Summary of Results: All 10 U.S. Caucasian samples were fully resolved after comparing coding region sequence data from the GeneChip®. A typical array experiment resulted in approximately 95% sequence coverage (the remainder being Ns or no calls). Comparisons between the GeneChip® and traditional sequencing indicated the array platform had difficulty calling insertions and deletions as well as some closely spaced polymorphisms.

Conclusions: At this time the mitochondrial resequencing array method requires more input DNA in contrast to traditional sequencing or even STR analysis. However, the array may find utility in full genome sequencing of family reference samples. Unique polymorphisms elucidated by the array can then be sequenced by traditional sequencing methods or typed using an appropriate SNP assay.

Mitochondrial DNA, Sequencing, Microarray

B185 Multiplexed SNP Detection System for Mitochondrial DNA

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After attending this presentation, attendees will learn about a novel SNP genotyping method and its use in the detection of mitochondrial SNPs.

This presentation will impact the forensic community and/or humanity by presenting optimization of a multiplexed SNP detection system and its application to mitochondrial DNA.

Single nucleotide polymorphisms (SNPs) are the most prevalent form of genetic variations in the human genome. Because of their low mutation rate, SNPs have the potential to be used as genetic markers in human identity applications such as paternity testing, genealogy studies, and human population genetics. In addition, the ability to be genotyped using very short DNA fragments, SNP genotyping may become a very important tool to analyze highly degraded and aged samples commonly seen in the forensic field. For the analysis of aged sample (e.g., bones) or samples that contain a small amount of biological material (e.g., hair), SNP markers on mitochondrial DNA are preferred over SNP markers on nuclear DNA because of multiple copies of mitochondrial DNA in a cell. The major goal of present study was to develop a sensitive, easy to use, rapid, and robust SNP detection method for forensic applications. A detection system for identification of mutations and SNPs was optimized. The method involves a multiplexed PCR amplification of as many as 48 regions in the mitochondrial genome, followed by detection of mutations or SNPs in these amplicons using an oligonucleotide ligation assay (OLA). Optimization of the multiplex PCR was achieved

using primer titration and minimizing primer-dimer formation. The ligated products were hybridized to coded sequences with mobility modifiers and detected by capillary electrophoresis. Direct detection by CE following ligation is also possible. To define the accuracy of the system total mitochondrial genomes were sequenced from 20 individuals using M13 tailed primers for PCR amplification designed to cover the entire genome.

A SNP detection multiplex assay comprised of multiple SNPs outside the hypervariable region was developed for mitochondrial SNP detection. Performance of the assay was evaluated by comparison with sequence approach. Complete concordance for more than 200 allele calls made with the PCR/OLA method and sequencing method was observed. The method was further evaluated for forensic application by using forensic type samples, such as vaginal swab, saliva, hair, urine, and blood stains. The results indicate that the SNP system is accurate, sensitive, fast (< 7 hour time for analysis), easy to perform, medium through-put, and robust.

Genotyping, Mitochondrial DNA, SNP

B186 The Application of New Non-CODIS Mini-STRs to Highly Degraded Samples

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After attending this presentation, attendees will understand the limitations of mtDNA testing and the utility of new mini short tandem repeat markers (STRs) on degraded remains. Attendees will understand how mini-STRs can be employed to sort samples with matching mtDNA profiles, particularly in complex cases and/or cases with a large number of remains. Attendees will also learn how non-CODIS miniSTRs can be used to complement low copy number (LCN) nuclear typing results obtained with commercial kits and, thereby, add weight to the identification of remains.

This presentation will impact the forensic community and/or humanity by demonstrating the potential utility of non-CODIS miniSTRs in the analysis of highly degraded human remains.

Highly degraded human remains pose a challenge to many forensic laboratories due to the difficulty of producing short tandem repeat (STR) profiles using standard nuclear DNA typing protocols. Some laboratories perform mtDNA sequence analysis on such highly degraded samples. However, mtDNA is not a unique identifier, due to maternal inheritance and lack of recombination. Sample individuation using mtDNA sequence analysis is further confounded by the small region of the mtGenome typically examined (hypervariable regions I and II, approximately 610 base pairs, or the entire control region), and by the existence of common mtDNA types resulting from founder effects, population bottlenecks, and genetic drift in human history. These characteristics of mtDNA typing virtually ensure that with large numbers of samples there will be multiple non-related individuals whose mtDNA profiles are identical. This particular limitation of mtDNA typing becomes significantly problematic in situations where remains have been commingled. In such cases, with mtDNA data alone, it may be difficult or impossible to simply determine the total number of individuals represented in a particular case/incident.

The development of new non-CODIS miniSTR markers for use with highly degraded samples has the potential for significant impact in forensic casework.^{1,2} Non-CODIS STRs will be particularly useful in sorting samples when multiple elements cannot be distinguished using mtDNA. Sorting can be accomplished by applying miniSTRs to those samples that share common mtDNA types. The results can then be used to reassociate remains and determine the number of individuals

represented. The results of typing with 8 non-CODIS miniSTR markers (D2S441, D2S1776, D3S4529, D6S474, D9S2157, D10S1248, ATA63, and D22S1045) on samples from a large set of commingled remains repatriated from North Korea will be presented. The size range of these eight non-CODIS markers vary from ~70-170 base pairs. Also included within the 8-plex is a single CODIS marker (D16S539) having a size range from ~235-275 base pairs, and acts as an internal control to assess the level of DNA degradation for the sample. MtDNA control region sequencing was previously performed on many of these remains. However, a large number of the sequences matched mtDNA types common in the Caucasian population, preventing individuation or even an accurate assessment of the total number of individuals represented. The miniSTR data presented will demonstrate that the sorting of such samples can be accomplished through the use of these non-CODIS nuclear markers.

In addition to the use of non-CODIS miniSTRs for sample sorting, these new markers will be used to complement LCN nDNA results and add weight to the statistics generated with CODIS markers. In cases with highly degraded remains it can be challenging to obtain high likelihood ratios (LRs) from partial profiles developed using LCN nDNA typing. Furthermore, in many of these cases, ideal reference material from direct reference samples and/or immediate kin are unavailable. The addition of supplementary markers to the calculations can increase LRs significantly when only partial profiles are recovered with CODIS markers and/or only extended kin are available as references. Data will be presented that shows the benefit of adding 8 non-CODIS miniSTRs (D2S441, D2S1776, D3S4529, D6S474, D9S2157, D10S1248, ATA63, and D22S1045) to samples that have been typed using LCN protocols for PowerPlex16 (Promega) and Y-filer (Applied Biosystems), and have also been sequenced in the mtDNA control region and typed for mtDNA coding region SNPs.

References:

¹ Coble, M.D., Butler, J.M. (2005) Characterization of New MiniSTR Loci to Aid Analysis of Degraded DNA. *J. Forensic Sci.* 50(1): 43-53.

² Hill, C.R., Coble, M.D., Butler, J.M. (2006) Development of additional new miniSTR loci for improved analysis of degraded DNA samples. *submitted.*

MiniSTR, Degraded DNA, Mitochondrial DNA

B187 Application of an Optimized SNP Detection System for Human Identification: Comparison With STR Profiling Methods

Manohar R. Furtado, PhD, Rixun Fang, PhD, Fiona Hyland, PhD, and Cristin O'Shea, BS, Applied Biosystems, 850 Lincoln Centre Drive, Foster City, CA 94404*

After attending this presentation, attendees will learn about a novel method for multiplexed detection of SNPs that employs PCR followed by an oligonucleotide ligation reaction and separation by capillary electrophoresis. They will be presented with comparative data on a set of samples genotyped using STRs and SNPs.

This presentation will impact the forensic community and/or humanity by demonstrating the capability to detect 48 SNPs from < 1 ng of biological DNA and indicate that SNP and STR based genotyping methods can provide comparable discriminatory power.

The hypothesis was that SNP detection methods will be comparable to STR analysis, provided that a large enough set of SNPs are tested. Currently, multiplexed analysis of short tandem repeats (STRs) provides the best solution with high power of discrimination and rapid analysis speed. However, single nucleotide polymorphism (SNP) profiling is also very powerful for human ID testing purposes especially in instances

where DNA is highly degraded, as with disaster victim identification (DVI), and in typing mitochondrial DNA. SNPs have also been used for paternity testing, genealogical studies and more recently in population based stratification of patient groups in clinical trials. A detection system for identification of known mutations and SNPs was optimized. The method involves a multiplexed PCR amplification of ~ 48 regions in the human genome, followed by detection of mutations or SNPs in these amplicons using an oligonucleotide ligation assay (OLA). Optimization of the multiplex PCR was achieved using primer titration and minimizing primer-dimer formation. The ligated products were hybridized to coded sequences with mobility modifiers and detected by capillary electrophoresis. Direct detection by CE following ligation is also possible. The SNPs used were based on a study by the SNPforID consortium, who selected a set of highly discriminative SNPs suitable for forensic analysis based on criteria described in Sanchez et al., (Electrophoresis 2006,27:1713). A gender specific deletion marker was designed.

To test the accuracy of the method and to compare relative utility of SNP analysis to STR analysis for human identification and paternity testing, a panel of 41 individuals from 3 different CEPH families spanning three generations was genotyped. The test samples were genotyped using 49 SNPs with the SNP detection system, and also with Identifiler™. To determine accuracy, the SNPs were also genotyped using the TaqMan® allelic determination method to yield 100% concordance. The results indicated that the overall informativeness is comparable, with about 45 SNPs being equivalent to Identifiler. The SNP panel was more informative for identity but less informative for paternity exclusion. In this data set, the SNP panel exhibited greater number of genotypic differences (mean ~19) compared to Identifiler (9) between closely related individuals. The SNP panel also exhibited a greater number of genotype differences (mean ~ 28) compared to Identifiler (mean ~ 14) between any two unrelated individuals. This trend was consistent in both full sibs and unrelated samples. And, while Identifiler™ has a higher probability of paternity exclusion, (about 10⁻⁷ for Identifiler and 10⁻⁵ for the SNPs when the mother's genotype is known); the SNP panel was better able to distinguish between close relatives for paternity identification. The SNP panel was also tested with degraded DNA and DNA from blood, semen, and saliva samples.

The results indicate that carefully selected SNPs can be as useful as STRs in human ID testing and related applications. The development of highly multiplexed SNP detection systems enabling lower cost, higher automation and higher throughput will result in increased use of SNP profiling in a number of applications.

SNPs, Genotyping, Human Identification

B188 Organizational Structure and Service Delivery: Matching Analytical Capacity to the Demand for Forensic DNA

Johanne Almer, MSc, Roger Frappier, MSc, Andrew Greenfield, MSc, Cecilia Hageman, PhD, John M. Laird, MSc, and Jonathan Newman, BSc, Centre of Forensic Sciences, 25 Grosvenor Street, Toronto, Ontario M7A 2G8, Canada*

The goal of this presentation is to deliver a novel approach to the re-structuring of forensic DNA operations in a mid to high throughput laboratory. The presentation will describe the impact of a re-organization on productivity and staff engagement. Attendees will be provided with change management strategies that can be employed in a forensic DNA laboratory.

This presentation will impact the forensic community and/or humanity by affording the forensic community the opportunity to discover and implement best practices regarding management of

laboratory operations that have been developed from real life experiences.

Learning Objective and Outcome: To provide an awareness of the impact of Business Process Re-Engineering (BPR) on re-organization and service delivery in a forensic DNA laboratory.

BPR has been described as a fundamental rethinking and radical redesign of business processes to bring about dramatic improvements in performance (Michael Hammer¹). It is the examination and change of five components of the business; strategy, processes, technology, organization and culture

To be able to make significant improvements with emphasis on expansion of services coupled with a reduction in turnaround times the Biology Section of The Centre of Forensic Sciences undertook a comprehensive examination and re-engineering of its work processes.

The approach taken during this initiative was in accordance with a framework and methodology for project management in the Ontario Public Service. There are five phases within this framework; concept, definition, planning, implementation and closeout

Concept Phase: The vision was to create a working environment that maximized productivity and efficiency while maintaining the job satisfaction of all staff and to increase management accountability and authority by clearly defining program areas.

In 2003 management proposed a 5-unit organizational structure comprised of two service units: DNA and case screening and three case management units responsible for the processing and reporting of one of three case types: high volume (HV), sexual assault (SA) and major crime (MC). In 2004 Process Re-Engineering Teams (PRETs) comprised of members of staff from the Biology Section developed processes and recommendations regarding the most efficient means of delivering forensic services within the proposed organizational structure.

Assault, robbery, and break and enter are examples of the types of cases that were classified as high volume and the HV PRET recommended processes required to maximize the throughput of items to facilitate rapid entry of DNA profiles onto the National DNA Data Bank of Canada (NDDDB) and the rapid reporting of results to investigators. Processes encompassed case assessment, roles of reporting scientists, the use of automated systems and the communication and management of "hits" generated from the NDDDB.

The SA PRET re-engineered processes and workflow in recognition of the generally standard format of submissions in these cases. Concepts promoted included the use of staged examination process for the targeting of relevant items, and the use of Y-STRs as a screening tool to replace conventional body fluid identification.

Homicide, Attempt Murder, Hit and Run are examples of major cases, the MC PRET recommended a process that recognizes the need for a tailored approach to major cases. The process included a formalized case consultation service utilizing a dedicated Scientific Advisor.

Definition: Upon implementation of these re-engineered processes, it was anticipated that the section will be better able to meet current demands, and will be poised to meet future demands for service delivery. Internally, the Section will be clearly structured in accordance with its objectives and managers will have increased accountability for service delivery. Staff would work in groups mandated to meet objectives and performance targets specific to their program area.

Planning Phase: In the spring of 2005 the re-organization occurred allowing operations to continue while implementation of team specific re-engineering recommendations proceeded according to a plan established during the year. The implementation plan continues to be overseen by a Project Management Team comprised of a cross-sectional representation of staff and management from within the Biology Section who are the Team Leads for each of the identified areas of change.

Implementation Phase: The re-engineering change initiatives have been planned to occur over an approximately two-year period that commenced at the end of 2005. At the end of the first year the impact on service delivery of the section re-organization and re-defined

management accountability that occurred in the spring of 2005 was already being realized.

The performance indicator for the section is the time from item submission to release of a report. For the fiscal year 2004 / 05 the percentage of cases reported within 90 days was 78% for high volume cases, 58% for sexual assault cases, and 62% for major cases. For the first quarter of the fiscal year 2006/07 the percentage of cases reported within 90 days was 97% for high volume cases, 81% for sexual assault cases, and 65% for major cases.

Re-engineering is ongoing and as part of a change management process strategies are in place to provide formal and informal mechanisms to support change. Staff training initiatives have focused on team building skills, including team training, Myers Briggs Type Indicator, and conflict styles inventory. The section has also initiated a staff engagement survey that is designed to identify and offer outlets for dealing with morale issues such as job satisfaction, stress, workload, communication, and management.

Summary: In summary, the key to successful achievement of any project is the blend of consideration for the needs of the product or service being developed, the people, and the organizations involved and affected. Proper scoping, definition, and planning for the project requires the participation of those involved and affected. Regular consultation, participation, and communication promote trust, and allow the building of relationships necessary for project success.

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¹ Michael Hammer and James Champy, Re-engineering the Corporation. Harper Collins.

Change Management, Organizational Structure, Forensic DNA

B189 Implementing a Criminalistics Based High School Curriculum — Theoretical and Practical Considerations

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After attending this presentation, attendees will gain an appreciation for a new instructional philosophy in developing a one-year high school or college class curriculum in forensic science centered on the science of criminalistics. The advantages of pairing a criminalistics professional with a high school instructor to integrate criminalistics theory and practice into the limitations of high school science classes will be described. Attendees will also learn a different paradigm of laboratory practice, the use of laboratory-based skill set building with critical thinking and problem solving, consistent with criminalistics practice, as the cornerstone of instruction.

This presentation will impact the forensic community and/or humanity by showing current and future instructors the importance of pairing a criminalistics professional with a high school instructor to integrate criminalistics theory and practice into the limitations of high school science classes and an alternate model of laboratory practice to stimulate critical thinking and problem solving. In addition to the six foundational concepts of criminalistics in this curriculum are the various skill sets required to be a capable forensic scientist including strong scientific knowledge, understanding of law and its affects on forensic science, good communication, and ethics. By providing both the philosophy and the science of criminalistics with an emphasis on critical thinking, impressionable students may have a better understanding of forensic science as practiced, which can have an effect on their eventual role as jurors or on their initial understanding of their potential career choice.

Too often non-forensic instructors of science consider criminalistics and forensic science as simply an application of their science; while some consider it as edutainment, and rarely do they treat

it as a separate science. Additionally, the concept of court and the legal system is foreign to most scientists as is good communication skills in the traditional science classroom.

In discussions with high school teachers and college instructors, who were teaching or wished to teach forensic science, it became clear that a lack of understanding of forensic science was present. For many, the CSI television model was reality and classes were based on broad categories described from the show or selected from various topics from the numerous books recently available. Some of the classes incorporated a diversity of non-profession related matter: memorization of forensic science trivia facts, inclusion of behavioral science/profiling, psychology of offenders, interview methods, homicide scene photo collections, or internet searching of notable crimes. Some classes have included only a few in-the-laboratory science experiments.

One high school instructor¹ teamed with a criminalist to develop a one-year forensic science curriculum. They focused on the science commonly practiced in the crime lab, keeping in mind the limitations of the high school science classroom. The curriculum was developed at the level of understanding of the college bound high school science student.

The criminalist developed the course concepts, skill set building laboratories, and many of the experiments, while the high school instructor taught the concepts and altered the skill set building and laboratories to suit the limitations of the high school science equipment, and collaborated in creating realistic assessments for the students. Constant feedback on the efficacy of the concepts and problems with the laboratories for the students resulted in immediate revisions of the content.

Since no one argues that having fundamental knowledge of the various natural sciences, such as physics, chemistry, and biology, is an essential requirement to be successful in the crime lab or the forensic science classroom, chemistry and biology classes were required before admission to the forensic science class. The goal was to show applicability of their fundamental knowledge to solving analytical problems, not to teach basic science concepts.

The curriculum incorporates and emphasizes the six foundational concepts of criminalistics: observation, documentation, collection, analysis, conclusion/interpretation, and communication. The class focus is on science used in the crime lab (crime scene investigation, various types of impression evidence, trace evidence, DNA, etc.) and not on the specialized areas of forensic science.

The first night's homework assignment is reading a portion of a chapter in a fictional detective story wherein a generalized description of crime scene approach is given. Observation, documentation, and communication being primary concepts in science and criminalistics, the students are teamed up and asked to process a crime scene on the second day. On the third day the students learn of the scene items they missed, their lack of documentation, and the lack of communication among the team members. This immediate immersion is to drive home several points: 1) observation, documentation, and communication are critical in forensic science, 2) crime scene processing is not what they understand it to be, 3) they don't know what they are doing yet and the class will be much harder than they thought, and 4) every reading assignment has not only theory but a practical application associated. The scene results are used as a baseline assessment of progress for the rest of the year. This first scene is not graded, but used as a learning opportunity. All first module reading and laboratories are designed to emphasize students building their observational skills, learning proper documentation, and improving communication abilities orally and in writing. These skills will not only be useful for the rest of this class, but all of their future science classes.

In the next module, students learn of the ethics, philosophy, and science of criminalistics as part of an introduction to forensic science and criminalistics. The students are taught that criminalistics is the science of individualization.² While analysis in criminalistics often results in identification, as it does in other sciences, the ultimate goal of criminalistics is in individualizing an item of evidence to a person, place,

or thing (the exemplars). This latter type of analysis differentiates criminalistics from other sciences.

Rather than providing students with a cookbook format to follow to complete a laboratory, the students are taught to build a certain task or skill. At the end of the laboratory, they are provided with a scenario and an unknown, which requires using their newly acquired skill set sometimes in a new way. Additionally, the solution may include utilizing any previously learned skill set to solve the problem. Critical thinking and problem solving are systematized into the curriculum. Information in the scenario must be carefully assessed to determine if it is consistent with the evidence or in order to make a conclusion or an interpretation. This integration of realistic criminalistics into the classroom benefits the student by requiring thought at nearly every step of the process. A written report and oral presentation in the form of testimony are required for several assessments during each semester and the final.

Before entering into the remaining traditional criminalistics topics, courtroom procedure and legal issues are presented to the students. In addition to laboratory skill building in this module, students are required to make oral presentations of their legal issues research project in front of the class.

By teaming the forensic scientist with the high school or college instructor, students benefit by the practical and realistic laboratories that are developed. Using the new paradigm for laboratory practice facilitates knowledge with critical thinking and problem solving. Emphasizing the six foundational concepts of criminalistics improves the students' abilities in each of these areas for forensic science and will further help the student in any future science class. Lastly, the emphasis on critical thinking and problem solving in the curriculum provides some students with the realization that forensic science may not be their career choice after all.

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Forensic Science Education, High School/College, Criminalistics Curriculum

B190 Analysis of ATM Security Ink at the FBI Laboratory

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After attending this presentation, attendees will learn information regarding procedures to analyze atm security ink. Various methodologies, along with their strengths and weaknesses, can be evaluated for use in their laboratories.

This presentation will impact the forensic community and/or humanity by demonstrating procedures and methodology will be presented that can be used in other forensic laboratories to analyze this type of evidence.

Bank security devices are disguised as a stack of bills with a hidden component that releases a red dye and/or tear gas when it is activated. These devices are given out by a bank teller during the course of a robbery to aid in the recovery of the stolen money. However, ATM machine robberies are increasing in numbers within the United States. Such acts of crime not only result in great losses of money, but also severe destruction of property to the bank and surrounding areas. 3SI Security has developed a security device to help protect ATM machines. When a robbery of an ATM machine occurs, and the money carriage is disturbed, an ink is released that will stain the bills contained within it. This staining renders the money useless, which can lead to its recovery. Advertisement for the presence of such security systems can also prevent any attempts of a robbery from the start.

The FBI Laboratory currently has validated procedures for the analysis of bank security devices involving the red dye and tear gas dye packs. This presentation will evaluate the techniques and methodology available to analyze evidence related to the ATM Security Ink systems.

ATM Security Ink, Forensic, Instrumentation

B191 Gunpowder Particle and Vaporous Lead Deposit Patterns on Fabric From Hand Gun Discharges

Kay M. Sweeney, BS, KMS Forensics Inc., PO Box 8580, Kirkland, WA 98034*

After attending this presentation, attendees will have learned about the deposit patterns for gunpowder particles and vaporous lead when selected handguns are fired into clothing fabrics using different ammunition and at different distances.

This presentation will impact the forensic community and/or humanity by demonstrating that the collection/manipulation history of clothing exhibiting gunshot defects seized as evidence during shooting scene investigations is extremely important in determining muzzle to target distances.

Outcome: Clothing items with bullet holes and gunpowder deposits as recovered from shooting homicide victims can be carefully evaluated for their collection/manipulation history, gunpowder particle deposit patterns and vaporous lead deposits and thereby provide a valuable foundation for muzzle to target distance determinations.

Gunpowder particle deposit patterns on clothing fabrics, particularly in the region of a bullet penetration defect, provide interpretive opportunities for forensic scientists interested in establishing an intervening distance measurement between the discharging firearm and the target clothing fabric. The same can be said for vaporous lead deposit patterns. This presentation reports on the results of testing conducted thus far involving one 9mm semi-automatic pistol using twenty one different rounds of 9mm Luger ammunition representing ten manufacturers or brands.

In order to establish baseline information relating to the source of lead in gunpowder particle deposit patterns on clothing the gunpowder, jacketed bullet and cartridge case of one round representing each of the ten manufacturers were tested using X-Ray fluorescence spectrophotometry, (XRF). All gun powders were found to contain lead ranging from 25 ppm to 180 ppm.

Next, one each of the ten representative manufacturer's cartridge cases with the live primer cap in place was fired in the 9mm pistol into white, 100% cotton t-shirt fabric at a muzzle to target distance of four inches. The resulting smoke and particulate deposit on the white cotton fabric was tested for lead using XRF. Lead content was noted in the range of from 7,000 parts per million (ppm) to 19,000 parts per million in the deposit. Copper, antimony, mercury, and zinc were also noted in significant quantities.

Then, one manufacturer's specific cartridge design was used in the 9mm pistol to fire into white 100% cotton t-shirt fabric at muzzle to target distances of 4", 6", 8", 10", 12", 14", 16", 20", 24", 30", 36", 42", 48", and 54". A template of concentric circles drawn at one inch, two inches, three inches, and four inches from the center point was prepared on clear Mylar sheet stock and this was used as an overlay on top of the test fire panels with the center point placed dead center on the bullet defect in the panels. The circles were scribed into quarters and during microscopic examination, counts for gunpowder particle deposits were made in one quarter of the circle.

The counts, for purposes of this presentation, are reported in three ways. One unit used is the number of gunpowder particles counted in a particular quarter circle area. The gunpowder particle count for the area ranging from the circle center point out to the quarter arc at one inch from the circle center is recorded as the "First Order Quarter-Circle Gunpowder Particle Count" and the number for the "Second Order Quarter-Circle Gunpowder Particle Count" is the number of gunpowder particles counted in the quarter of circle area ranging from the circle center point out to the quarter arc at two inches from the circle center, and so on. Another unit used is the calculated density of gunpowder particles in a particular designated quarter of a circle area and that figure is recorded using the appropriate quarter-circle reference as "First Order Quarter-Circle Density," "Second Order Quarter-Circle Density" and so on. The third unit is the gunpowder particle count for a particular "Quarter-Arc Band" in which gunpowder particle deposits were found. For instance, the "First Order Quarter-Arc Band" is the same space as that designated by the "First Order Quarter-Circle" area and the "Second Order Quarter-Arc Band" is the area between the quarter circle perimeter at one inch from the bullet penetration center and the quarter circle perimeter at two inches from the bullet penetration center, and so on. Gunpowder particles were found on the test panels out to a muzzle to target firing distance of 54 inches.

Finally, using the 9mm pistol, one each of the twenty one rounds representing varying cartridge configurations of the ten manufacturers were fired into white, 100% cotton t-shirt fabric from a consistent muzzle to target distance of 10 inches. Gunpowder particle deposit counts were tabulated for the various orders of "Quarter-Circle" and "Quarter-Arc Band" areas. Six test-fire panels were selected from this group and XRF analysis was performed in the "First Order Quart-Arc Band," "Second Order Quart-Arc Band", "Third Order Quart-Arc Band", and "Fourth Order Quart-Arc Band" areas. The range of lead content was from 147 ppm to 732 ppm in the "First Order Quart-Arc Band", from 55 ppm to 333 ppm in the "Second Order Quart-Arc Band", from 62 ppm to 223 ppm in the "Third Order Quart-Arc Band" and from 32 ppm to 147 ppm in the "Fourth Order Quart-Arc Band". The same six panels were then subjected to manipulation typical of procedures used for collecting a t-shirt from a person shot in the chest and found deceased at an indoor scene. This was accomplished by pinning the fabric panel from the test firing process to the chest of a volunteer wearing a t-shirt, rolling the body of the volunteer on the scene, wrapping the volunteer in a sheet, lifting and carrying the volunteer, opening the transporting sheet, removing the volunteer's t-shirt over her head, hanging the t-shirt on a hanger, removing the t-shirt from a hanger, placing the t-shirt in a brown paper bag and closing it, handling the paper bag, opening the paper bag, removing the t-shirt and spreading the t-shirt out on an examination table. After this process the selected six panels were examined microscopically and gunpowder particle counts were conducted. One panel of the six manipulated panels showed an increase in quarter-circle area gunpowder particle deposit counts while the other five showed an average decrease of; 13% in gunpowder particle deposit count in the first order quarter-circle, 20% in the second order quarter-circle, 20% in the third order quarter-circle and 22% in the fourth order quarter-circle.

Clothing items with bullet holes and gunpowder deposits as recovered from shooting homicide victims can be examined and analyzed for their gunpowder particle deposit patterns and vaporous lead deposits for the purpose of muzzle to target distance determinations, however it is equally important to carefully evaluate their collection/manipulation history before expert opinions are communicated.

Gunpowder Patterns, Vaporous Lead, Primer Smoke

B192 Evaluating and Enhancing the Forensic Sciences: Scientific Foundations and Best Practices

Bruce Budowle, PhD, FBI Laboratory, 2501 Investigation Parkway, Quantico, VA 22135; and JoAnn Buscaglia, PhD*, FBI Laboratory, Counterterrorism & Forensic Science Research Unit, FBI Academy, Building 12, Quantico, VA 22135*

After attending this presentation, attendees will learn the salient issues identified at a mini-forum assessing the validity of the scientific foundations and current practices of some of the experientially based forensic disciplines, including mechanisms to facilitate enhancing the forensic sciences under consideration and developing strategies for improvement.

While the fundamentals of experientially based forensic analyses are sound, improvements can be made. Critical self-evaluation, scientific exchange, and research are the best methods to identify gaps and enhance forensic practices. This presentation will impact the forensic community and/or humanity by providing the forensic science community with results of such an evaluation, as well as a mechanism for open discussion and collaboration, to facilitate improvements in forensic practices.

Forensic scientists routinely perform comparisons between evidence and reference samples to render interpretations/opinions for exculpatory and inculpatory purposes. The underlying premise for such identifications is that, depending on the quality and quantity of the forensic evidentiary materials, distinguishing features can be exploited for various degrees of source attribution. In the 21st century, new technologies, advanced automation, and sophisticated computer analysis capabilities permit higher standards for scientific practices and critical assessment and testing of accepted practices. Opportunities exist now more than ever before to improve forensic practices. Therefore, forensic scientists should consider periodically evaluating the validity of the scientific foundations of the forensic sciences, the practices currently used, and developing strategies for improvement. Research should be pursued to challenge past practices and develop new and, hopefully, improved approaches.

With such opportunities, the forensic science community should coordinate and collaborate to attain the best practices possible. In this regard, the Forensic Science Service and the FBI Laboratory co-organized a mini-forum, in conjunction with the EAFS2006 conference, on evaluating the scientific foundations of some of the experientially based forensic disciplines. The goals of this mini-forum were to: 1) identify gaps in the foundations of scientific practices; 2) foster relationships to effectively leverage resources both intellectually and economically; 3) develop strategies for better communication internationally for terminology and peer review; 4) exchange and assess research and development and current practices; and 5) establish mechanisms for collaboration to avoid duplication of efforts. The disciplines that were addressed are: 1) latent prints; 2) handwriting comparisons; 3) impression evidence (tool marks, shoes, tires, etc); and 4) trace evidence (e.g., hairs, fibers, glass).

While the fundamentals of experientially based forensic analyses are sound, improvements can be made. Fostering scientific exchange and critically evaluating disciplines is the best avenues for enhancing forensic practices. To continue the process of critical self-evaluation of this science, the salient issues identified at the mini-forum and mechanisms to facilitate enhancing the forensic sciences under consideration will be discussed. An open discussion and collaboration among forensic scientists is necessary to foster scientific exchange and critically evaluate this discipline. This presentation will consist of brief oral presentations with an expert panel exchange, which is designed to encourage open discussion and attendee participation.

Impression Evidence, Handwriting, Trace Evidence

B193 Systematic Optimization of Instrumental Conditions: Ion Mobility Spectrometry as a Model Device

José R. Almirall, PhD, and Hanh T. Lai, BS, Florida International University, Department of Chemistry, 11200 SW 8th street, Chemistry and Biochemistry Department, FIU University Park, Miami, FL 33199*

After attending this presentation, attendees will understand a method of finding optimal conditions for an ion mobility spectrometry instrument.

This presentation will impact the forensic community and/or humanity by demonstrating how to use ion mobility spectrometry as a device to detect evidence and how under optimal conditions the instrument's selectivity and sensitivity is greatly enhanced.

This presentation presents the optimization results of an existing Solid Phase Microextraction-Ion Mobility Spectrometer (SPME-IMS) interfaced system previously developed by this group as a sampling and pre-concentration device to collect volatile drugs or explosives (or taggants) and the volatile compounds believed to be odor signatures of drugs and explosives using an IMS detector.

This group and other researchers have demonstrated that improvement in the analysis of several organic explosives and taggants is achieved by varying the drift tube temperature of the IMS instrument^{1,3} by promoting adduct stability. These changes to analysis temperature lead to different product ion distributions which can be used to resolve interferences from the analytes.² Additionally, product ion identities can be manipulated through the addition of chemicals to produce alternative reactant ions.² Therefore, changes to reactant ions may also lead to different product ion distributions, and thus make these products easier to resolve in the IMS. The optimization presented varies several parameters as well as the variation of the dopant gas used for the SPME interfaced IMS instrument.

The optimization procedure developed can be used for finding the optimal operating conditions of an IMS system for any compound of interest. The search algorithm lends itself to the class of problem where the IMS instrument has a number of settings/parameters that can be varied, and therefore has a large number of possible configurations which is difficult and time consuming to evaluate exhaustively through a random search routine. The optimization procedure approach is available in a programming file and is ready to be used. Once the investigator defines a problem domain (ranges of the various operating parameters), the algorithm can be applied to optimize the detection performance of the IMS instrument for a specific compound.

This study developed a methodical and objective method of optimization to enhance selectivity and sensitivity in the IMS for a list of drugs and explosives and their volatile/semi-volatile chemical marker compounds such as DMNB, 2-E-1-hexanol, cyclohexanone, 2-nitrophenylamine, diphenylamine, methyl benzoate, piperonal, benzaldehyde, and acetic acid. Once the optimal settings of each of these compounds are found, their limits of detection were determined at their optimal settings and also presented.

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Optimization, IMS, Explosives and Narcotics

B194 Forensic Applications of Chemometrics: Statistical Comparison of Differential and Ion Mobility Spectrometry for Gas Chromatographic Detection and Three-Way Classification of Ignitable Liquids From Fire Debris

Peter B. Harrington, PhD, Ohio University, Department of Chemistry & Biochemistry, Athens, OH 45701-2979; and Yao Lu, BS, Ohio University, Center for Intelligent Chemical Instrumentation, Department of Chemistry & Biochemistry, Athens, OH 45701-2979*

After attending this presentation, attendees will have learned about the benefits of gas chromatography and multi-channel detection by ion and differential mobility spectrometry, intelligent instrumentation that automatically classifies samples based on the complete set of data furnished by the analytical measurement, and how to statistically compare method performance using analysis of variance.

This presentation will impact the forensic community and/or humanity by demonstrating that:

1. Ion mobility spectrometers are routinely used by law enforcement and security agencies, but the coupling of these instruments to gas chromatographs is somewhat rare, yet this coupling greatly increases the amount of information furnished for complex samples.
2. Three-way classification is very important to the forensic community because it provides a powerful method for comparing complex samples that exploits all the information furnished from the measurement. Typically, two-way classification is used which discards significant chemical information.
3. Differential mobility is a new and burgeoning method for ion measurement that complements ion mobility spectrometry.
4. The audience will learn to use analysis of variance for statistically comparing two complex instrumental methods. Although this method is old and simple, its use is often neglected and as a consequence many scientific studies are inconclusive.

Forensic analysis of paper was one of the earliest papers to incorporate the term chemometrics and report the use of pattern recognition of chemical profiles.¹ The approach of using chemical profiling as forensic evidence has been expanding, with DNA typing being the most quintessential and prevalent example. The role of chemometrics in the forensic sciences is evolving which is driven by lowered cost of chemical sensors, rising demand for security, and the increased costs of criminal justice. The classification of petroleum-based ignitable liquids is of forensic importance in arson investigation. Arson causes great losses in lives and money. In 2003, the U.S. Fire Administration estimated that there were 37,500 intentionally set structure fires, which resulted in 305 civilian deaths and \$692 million in property loss.²

A fuzzy rule building expert system (FuRES)³ was used for three-way classification of different types of accelerants from fire debris according to their gas chromatography-ion mobility spectrometry and gas chromatography-differential mobility spectrometry (GC-DMS) maps. The two detectors differ in the modes of ion formation and selection. The IMS uses a radioactive ⁶³Ni source to form both positive and negative ions. The DMS uses a 10.6 eV source to furnish ions. Both sensitivity and selectivity of the two detectors will be compared.

Different types of ignitable liquids, such as gasoline, kerosene, turpentine, and paint thinner, were analyzed. Nylon and polyester carpet samples were used for the fire debris. Polydimethylsiloxane solid-phase microextraction (SPME) was used for the sample collection of the headspace above the fire debris. Pattern recognition of the three-way

data allowed the identification of the ignitable liquids from headspace samples of the fire debris. Bootstrap analysis of the FuRES discriminants coupled with Latin-partition⁴ allowed peaks specific to the accelerants to be extracted, characterized with respect to retention time and compensation voltage, and statistically ranked with respect to significance.

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Chemometrics, Ignitable Fluids, Gas Chromatography-Ion Mobility Spectrometry

B195 Study of Detection Limits of Odor Signatures of Drugs of Abuse Using SPME GC-MS and SPME-IMS

Monica L. Joshi, MS, and José R. Almirall, PhD, Florida International University, 11200 Southwest 8th Street, CP 194, Miami, FL 33199*

After attending this presentation, attendees will have learned about the use of IMS instrumentation for detection of illicit drugs based on odor signatures.

This presentation will impact the forensic community and/or humanity by demonstrating how the field detection of drugs based on their specific odor signatures will help law enforcement agencies. It is the instrumental detection of compounds detected by canines.

Controlled substances are routinely analyzed and identified by Gas Chromatography-Mass Spectrometry in the laboratory. The presumptive detection of drugs and explosive particles has been demonstrated by Ion Mobility Spectrometry for some time. The use of IMS has become more widespread due to its portability, ease of use and rapid analysis time. Over 10,000 IMS instruments are now performing an estimated 10 million analyses/year in field environments. IMS have also been shown to improve the detection limits over GC-MS by an order of magnitude.¹

Traditionally canines have been used to indicate to the presence of illicit drugs in public areas and ports of entry by law enforcement officials. Dogs have been found to alert to very low levels of substances.² Previous work has reported that dogs alert to the vapor generated by the substances of interest.² Further studies analyzing the headspace above the drugs and explosives and the specific odor compounds (volatile chemical markers) for the various narcotic drugs have been reported. These compounds include Methyl benzoate for cocaine and Piperonal for Ecstasy and others like Camphor and MDP2P.

This presentation presents data from a study conducted to determine detection limits of these above compounds. Solid Phase Micro-Extraction (SPME) is a sensitive, pre-concentration, and sampling technique. SPME when coupled to GC-MS and IMS increases the detection capabilities of these instruments. It allows for the concentration of volatile compounds prior to the analysis. SPME pre-concentrators have been used widely with GC-MS and present no analytical challenges. Previous work done in this laboratory has reported the successful coupling of SPME with IMS. This enables for field sampling and detection by already deployed IMS units.

Since SPME presents itself as a good tool for the analyses of volatile compounds, it is used in this current study for pre-concentration of chemical markers. This presentation also presents data detailing the study done to determine the amount of mass transfer to the SPME fiber that is sufficient to elicit a signal above detection limits for both GC-MS and IMS instruments. Ion mobility spectrometers used in this study include the bench-top and portal configurations. Sampling parameters and instrument parameters vary for each of these instruments and hence they are optimized prior to analysis.³

These results will improve the understanding of the instrumental detection of the drugs of abuse and lead to improvements in the detection of controlled substances through their odor compounds.

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Odor Signatures of Drugs, SPME-IMS, Methyl Benzoate

B196 Applications of IMS to Clandestine Laboratory Evidence

Suzanne C. Bell, PhD, West Virginia University, Bennett Department of Chemistry, 217 Clark Hall, Morgantown, WV 26506*

After attending this presentation, attendees will understand potential applications of ion mobility spectrometry for field screening of clandestine laboratory evidence as well as the pros and cons of integrating this analytical tool into clan lab investigations and remediation.

This presentation will impact the forensic community and/or humanity by demonstrating the use of ion mobility spectrometry applied to clandestine laboratory investigation (lab and field) from discovery through remediation.

Currently there are two common methods of methamphetamine synthesis used in clandestine laboratories: the Nazi/Birch method and the red cook/phosphorus method. From set-up through abandonment, such laboratories present significant law enforcement, forensic, and environmental problems. When laboratories are found, the first issue is what items should be collected for analysis, a task that often demands screening of dozens of pieces of evidence. Alternatively, most or all items are submitted to the laboratory, which transfers the responsibility for sample screening and selection to the forensic analyst. Once sites are secured and evidence collected, tasks switch to disposal and clean-up. Clean-up operations are best monitored analytically, but this is often limited by time and financial resources.

Ion mobility spectrometry, which can be deployed in the field or as a laboratory instrument, offers promise for rapid sample screening for clandestine drug laboratory evidence and remediation. In the field, IMS can be used for sample selection and tentative identification ancillary

materials such as precursors. In the laboratory, the instrument can be configured to rapidly screen samples including solids and multi-phase liquids. A typical IMS screening analysis requires a few seconds and is semi-quantitative and therefore allows for rapid and efficient screening of potential evidentiary materials. IMS can also be used to provide insight into the synthetic method used through identification of precursors, ingredients, and intermediates, providing significant investigative information. Finally, IMS can assist in clean-up and remediation activities by providing rapid presumptive testing on-site.

Field and laboratory ion mobility spectrometers were utilized to characterize typical ingredients for both synthetic methods, typical products, by-products, and wastes. The value of IMS as a field and laboratory screening device for clandestine laboratory evidence will be discussed in analytical as well as cost/benefit terms. Strengths and limitations of this approach will be presented.

Ion Mobility Spectrometry, Clandestine Labs, Methamphetamine

B197 Taking the Forensic Science Out of Drug Identification

Walter F. Rowe, PhD, Department of Forensic Sciences, The George Washington University, Washington, DC 20052*

After attending this presentation, attendees will learn the basic principles of ion mobility spectrometry (IMS) and the limitations of this analytical methodology for the identification of drugs. The attendee will also be familiar with SWGDRUG and ASTM Committee E30 guidelines for the forensic analysis of seized drug samples.

This presentation will impact the forensic community and/or humanity by alerting the forensic community to the existence of seized drug analysis programs in which non-forensic scientists conduct forensic drug analyses. The analytical method used (ion mobility spectrometry) does not yield a confirmed identification of any drug.

Ion mobility spectrometry (IMS) has found widespread use as a screening tool for the detection of explosives and drugs. In four drug cases (two originating on Maryland's Eastern Shore) prosecutors proffered an IMS scan as the sole method for the identification of cocaine. In three of the four cases, the analyses of the suspected drugs were conducted by U.S. Army National Guard units, rather than trained forensic scientists. The manufacturers of ion mobility spectrometers make the claim in their promotional literature that their instruments can 'detect and identify' drugs. However, the forensic science research literature does not support a claim that IMS is sufficient by itself to identify any drug. Furthermore, the guidelines for forensic drug identification promulgated by SWGDRUG and ASTM Committee E30 require a minimum of two uncorrelated methods of analysis. The SWGDRUG and the ASTM Committee E30 guidelines require that IMS be used with at least two other methods of analysis. Examination of plasmagrams from IMS instruments shows that IMS is equivalent to a chromatographic separation with 7,000 to 8,000 theoretical plates. IMS separates analytes better than packed column gas liquid chromatography but not as well as capillary column gas liquid chromatography. Having drug exhibits analyzed by technicians who are not trained forensic scientists leads to further problems. In one case, seven currency exhibits seized at different locations in the suspect's home were aggregated and analyzed by a single IMS scan.

Seized Drugs, SWGDRUG, Ion Mobility Spectrometry

B198 Criminal Paternity DNA Testing of Microscopically Identified Chorionic Villi in Formalin-Fixed Paraffin-Embedded Products of Conception

Ann E. Gordon, BS, Michigan State Police Lansing Laboratory, 7320 North Canal Road, Lansing, Michigan 48913; Joyce L. deJong, DO, Sparrow Hospital Forensic Pathology, 1215 East Michigan Avenue, Lansing, MI 48909; and David R. Foran, PhD, Michigan State University Forensic Science Program, School of Criminal Justice and Department of Zoology, 560 Baker Hall, East Lansing, MI 48824*

After attending this presentation, attendees will understand an effective method of DNA extraction of early abortion materials for the purpose of obtaining embryo/fetal DNA profile information.

This presentation will impact the forensic community and/or humanity by introducing the effectiveness of combining the techniques of microscopic-identification of chorionic villi and DNA extraction of formalin-fixed, paraffin-embedded early abortion materials. This will aid in generating complete embryo/fetal DNA profiles to utilize for discriminating criminal paternity comparisons. The primary application is for statutory rape cases where intercourse was consensual but illegal, and other associative biological evidence was not recovered due to the time frame of discovery.

Prior to 2002 and this research, early abortion material cases were not consistently or methodically pursued in Michigan State Police Laboratories. In early abortions, embryonic/fetal anatomy is not easily identified due to the abortion process and/or the developmental stage. Random sampling of the tissues for DNA analysis was utilized and often results were only maternal due to the overwhelming ratio of maternal decidua to embryonic/fetal tissue. Recent research identified a procedure to microscopically-identify embryonic/fetal tissues from early abortion materials. The procedure included formalin-fixation of the tissue; however this process is known to cause problematic STR DNA analysis, especially with exposures longer than 12–24 hours. In early 2003, the Michigan State Police Lansing Laboratory and Sparrow Hospital's Department of Pathology, Lansing, MI partnered to compare two different methods for the extraction of formalin-fixed, paraffin-embedded, and microscopically-identified chorionic villi (embryonic placental tissues).

The resultant embryonic/fetal tissue and maternal decidua from an early term elective and multiple spontaneous abortions were examined for identifiable embryonic/fetal anatomy—with none identified. The specimens were divided into a total of 50 sections and were formalin-fixed, paraffin-embedded, sectioned, stained, and mounted for microscopic examination. Chorionic villi were microscopically-identified for STR DNA analysis. Xylene deparaffinisation and tissue lysis buffer digestion were employed prior to DNA extraction to maximize the release of DNA from the tissue substrates. Since past extraction efforts utilizing traditional organic methods from formalin-fixed tissue often resulted in poor-quality degraded DNA and/or limited recovery of viable DNA for amplification, two extraction procedures, Chelex® and phenol/chloroform/isoamyl alcohol (organic), were compared in ability to recover the highest quantity and best quality DNA.

Results from the extractions revealed that significantly higher quantities of DNA were obtained from the Chelex® extracted samples, as well as significantly higher quality DNA profile information (full Profiler Plus™/Cofiler™ profiles). The STR results exhibited varying proportions of embryonic/fetal and maternal alleles—from single-source profiles to an equal mixture of contributors. Upon discernment of the offspring profile, aided by comparison to the maternal reference sample profile, comparison to the putative father was possible for determination of association. In actual casework, subsequent calculation of a likelihood ratio would assign statistical strength to the association.

The Chelex® extraction method for this application was implemented in early 2004 at the Michigan State Police Lansing Laboratory. The methods for quantification, amplification, and capillary electrophoresis had been validated and utilized for casework prior to this research; therefore, validation of the extraction procedure was quick and simple, and should be for other laboratories as well. At the current time the procedure is conducted at the Lansing facility exclusively; however, the Michigan State Police Laboratory system is working to train personnel at each of its three DNA laboratories. The caseload is approximately 10–15 cases per year in the Lansing Laboratory service area. Since implementation, at least five cases have been adjudicated with resultant convictions of Criminal Sexual Conduct in the Second Degree (CSC II) or Criminal Sexual Conduct in the Third Degree (CSC III) as a direct result of analysis. Sentencing ranged from 3 years probation to 15 years incarceration.

DNA Extraction, Formalin-Fixation, Chorionic Villi

B199 A Statistical Approach to the Identification of Criminals and Mass Disaster Victims Through Kinship DNA Database Searches

Kristen E. Lewis, MS, University of Washington, Department of Genome Sciences, Seattle, WA 98195-7730; Bruce S. Weir, PhD, University of Washington, Department of Biostatistics, Seattle, WA 98195-7232; and Mary-Claire King, PhD, University of Washington, Department of Genome Sciences, Seattle, WA 98195-7720*

After attending this presentation, attendees will learn how to use familial searching/genetic kinship analysis to generate investigative leads that would otherwise go undetected by the current database searching methods.

This presentation will impact the forensic community and/or humanity by providing new methodology to aid in the identification of suspects in unsolved cases and victims of mass disasters or human rights abuses.

The typical use of state and federal forensic DNA databases (i.e., Combined DNA Index System or CODIS) for comparison of unknown biological evidence profiles with known offender profiles has increased dramatically in the past several years as the number of database profiles grows and as it becomes legal to include misdemeanor offenders and arrestees in these databases. However, in certain situations encountered by forensic scientists and law enforcement, a direct search of local, state, or national CODIS databases will not produce a hit if the contributor of the evidence either has not been convicted of a felony or has not been arrested in a state that allows arrestee testing. Without any other evidence in these cases, the investigation and prosecution will stall.

One way to generate investigative leads in these situations is to perform indirect searches of the CODIS database. In this process, the unknown evidence profile is searched against the CODIS database to identify possible close relatives of the true offender, as these individuals would share more alleles with the true criminal than an unrelated person would. This type of search, called familial searching or genetic kinship analysis, has been routinely used to identify victims of mass disasters, human rights violations, and missing persons cases. Most states do not have legislation that explicitly addresses whether or not evidence profiles can be searched against the database to find partial profile matches with individuals who may be close relatives of the person from which the evidence came.

Likelihood ratio calculations can be used to assess the probability of identifying a close relative (i.e., parent-offspring, full or half-siblings, or uncle-nephew) depending on the hypothesized relationship by comparing the frequency and number of alleles shared between the evidence and each database profile (Brenner and Weir, 2003; Bieber et al., 2006). The largest likelihood ratios are typically the true relative, but unrelated individuals may generate high likelihood ratios by chance.

This presentation will describe a model-based approach that simulates a familial search of forensic databases by using FBI data composed of 13 CODIS STR genotypes from six populations (Budowle and Moretti, 1999). Each population database contains approximately 200 individuals. The allele frequencies at each CODIS locus are calculated for each population database. In the parent-offspring scenario, the model simulates a search of an evidence sample profile (“child”) against all persons in the database, which includes the child’s true “parent.” To do this, two individuals from one database are randomly chosen to be hypothetical parents. Their profiles are used to generate a child’s profile according to Mendelian rules of inheritance. This child’s genotype is searched against every offender’s profile in the database including his parents’, and the likelihood that the two compared individuals have a parent-child relationship versus that they are unrelated is calculated using the allele frequency data. The likelihood ratios are rank ordered and the position of one of the true parents (randomly selected) is recorded. This process is repeated to generate 1,000 likelihood ratios and corresponding ranks of one of the true parents. This information can be used to identify the probability of finding a true parent in a forensic database based on the use of likelihood ratios. A similar methodology will be presented for the far more complex sibling and uncle-nephew cases.

Familial Search, CODIS Database, Likelihood Ratio

B200 Finding Criminals Through DNA of Their Relatives

Charles H. Brenner, PhD, DNA-VIEW and School of Public Health, UC Berkeley, 6801 Thornhill Drive, Oakland, CA 94611; David Lazer, PhD, Kennedy School of Government, Harvard University, Cambridge, Mass 02138; and Frederick R. Bieber, PhD, Harvard Medical School, 260 Longwood Avenue, Boston, MA 02115*

After attending this presentation, attendees will learn how familial searching of offender DNA databases should be done and how it can produce a socially significant rate of investigative leads, as well as caution about the potential risks and controversies attendant on the practice.

This presentation will impact the forensic community and/or humanity by informing the community about a potential crime solving tool about which there is a very current controversy. Traditionally the FBI wouldn’t touch it, the UK tried it sporadically, and states regarded it nervously. Lately the UK has shown great interest and several recent successes, and in June 2006 the FBI cracked open the door towards approval – developments which have begun to stir public discussion and debate.

This presentation describes a new method for relationship searching in DNA offender databases to generate leads to criminals.¹ The method is immediately practical and figures to increase the “cold hit” rate by a significant amount. It also raises many interesting public policy issues and will accentuate and sharpen ethical debate about offender databases and especially relationship searching.

Heretofore relationship searching has been only sporadically effective. The most famous instance is the capture in 2003 of Jeffrey “Cellophane man” Gafoor for the vicious 1988 murder of Lynette White. Gafoor was not in the UK offender database but his 14-year-old nephew was and fortunately among their shared alleles was one rare one. A successful search based on that rare allele was the critical link in finding Gafoor.

The occasional successes up to now in finding criminals who are in the database “by proxy” – represented by their criminal relatives – have similarly relied on ad hoc searching methods – rare-allele coincidence or “low-stringency” (allele-counting) searching. Neither method works very often. This presentation therefore considers and explores the theoretically far preferable idea of computing the actual kinship

likelihood ratios between crime stain and database profiles so as to give full and proper weight to all alleles, shared and unshared, rare or common. Computer simulations show that such “kinship” familial database searching would produce a substantial percentage of new “cold hit” leads. If augmented by additional winnowing strategies – geographical considerations and especially Y-haplotyping of the more promising leads – the cold hit yield can be multiplied further. The method is practical now, and in fact will have been employed with the UK offender database for live cases by the time of the presentation.

Along with technical possibilities come public policy implications. If offender databases have the potential for abuse (as yet not clearly explained), the potential must be all the greater when kinship searching expands the paradigm of database searching from the individual to the family level. Is the system unfair if certain demographic groups – the poor and the racial minority – who never even committed a crime are over-represented (by proxy) in the offender database? Familial searching in particular (while generally acceptable in the UK) seems to be unapproved in U.S. but reasons are vague – invasion of privacy? Fear of public alarm? If inequity is the issue there are two possible resolutions: no database or a universal one. Thus far there has been only a murmur in either direction. Through pressing the issue perhaps that will change.

Kinship searching has the potential to extend the reach of offender databases far more than has been realized up to now, hence the opportunity to have an important impact on the prosecution and consequently the prevention of crime. Both the pros and the cons of this potential should be explored.

Reference:

¹ Bieber FR, Brenner CH, Lazar D, Finding Criminals through DNA of their Relatives, Science, June 2, 2006

Familial Searching, DNA Identification, Offender Database

B201 Automation of Casework and Forensic Reality

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After attending this presentation, attendees will become familiar with some of the challenges encountered while implementing the automated process for general casework at the RCMP. Learning about the limitations of the DNA extraction process based on magnetic beads will assist them in creating options for samples that are incompatible with automation.

This presentation will impact the forensic community and/or humanity by demonstrating how the adoption of an automated approach for casework processing provides immediate benefits to the community. In the past year, there has been an increase in the number of samples processed with a concomitant reduction in turnaround time. Over the course of almost four years, automated protocols, integrated with a LIMS-based computer tracking system, have been developed for direct DNA extraction, differential DNA extraction, DNA quantification, sample normalization, PCR setup, and post-PCR setup. The global automation system has been in place for close to one year now and the sharing of experience and the identification of the limitations of it should benefit forensic scientists currently contemplating automation for casework.

This presentation discusses the challenges encountered while implementing automation for general casework at the RCMP. Both advantages and limitations of a semi-automated DNA extraction process based on magnetic beads will be presented in a lessons-learned approach, which will benefit forensic laboratories working in this field.

Automated DNA extraction in the forensic laboratories was introduced in a stepwise modular approach. In 2000, the RCMP implemented a successful fully integrated and automated approach for the processing of convicted offender samples submitted to the National DNA Data Bank of Canada. This process combines the chemistry specific to FTA® cards and Sample Tracking and Control System™ (STaCS™). The process was adapted to work on TECAN Genesis RSP 150/8 robotic workstations equipped solely with non-disposable tips. In 2004, a fully integrated and semi-automated approach was successfully implemented for the processing of high volume DNA casework using non-suspect Break and Enter samples. The process was based on DNA extraction using Promega DNAIQ™ magnetic beads and DNA quantification using the ABI Quantifiler™ assay. The Key to success was the integration of specific robot tip washing routines designed to prevent cross-contamination of samples while ensuring that these measures did not add significant amount of time to the overall process. A key secondary advantage was that the fixed tip approach would also significantly decrease the overall cost of automated processing compared to protocols using proprietary liquid sensing disposable tips. The next increment for the automated forensic DNA objective was to develop a Sample Normalization module and an automated differential DNA extraction protocol which would accommodate all casework-type samples. In September 2005, the RCMP initiated the process for general casework samples using automated extraction. Some of the challenges that were encountered while processing casework samples included: 1) occasional imbalances in the heterozygous allele peak height ratio noted in STR profiles (it was noted that the use of the ABI DNA standard for real-time PCR quantification overestimated the amount of DNA present in the samples; reverting to the K562 standard solved the issue), 2) lack of success for some hemochromagen-positive questioned samples, some semen-positive samples and some known FTA samples with biological samples processed using DNAIQ™ magnetic beads. Each operational challenge noted above was evaluated by simulation experiments within the R&D environment. This resulted in recommendations involving sample size and adjustments in lysate volume to secure results using a manual route. Monitoring of the automated extraction process over the last 11 months indicates an increase in the overall number of samples processed and the successful processing for the majority of samples encountered in operational casework. However, the option of manual extraction remains and additional optimization of the automated processing will be inevitable since forensic casework samples will encounter many unknown environmental insults and new challenges previously not identified to either automated or manual processing of biological exhibits.

The adoption of an automated approach for casework processing provides immediate benefits to the forensic laboratory. This should increase the number of samples processed, reduce the manual intensive nature of DNA processing, and ensure tracking of each sample

throughout the process: direct DNA extraction, differential DNA extraction, DNA quantification, sample normalization, PCR setup, and post-PCR setup. Routine processing of large numbers of samples will free up time for solving problems encountered with challenging exhibits. This automated approach for casework has been in place for close to one year now and the sharing of experience and the identification of the limitations and advantages should benefit forensic scientists currently contemplating automation.

Automation, Casework, Magnetic Beads

B202 DNA Extraction of Forensic Casework Samples Using the Maxwell™ 16 Robotic Platform

Curtis D. Knox, Michael Bjerke, MS, and Daniel Kephart, PhD, Promega Corporation, 2800 Woods Hollow Road, Madison, WI 53711*

After attending this presentation, attendees will learn about a new low- to medium-throughput robotic DNA extraction platform and a DNA extraction kit that has been designed specifically for utilization with forensic casework samples.

This presentation will impact the forensic community and/or humanity by demonstrating data directly relevant to the extraction of actual forensic DNA case work samples to those DNA laboratories that have not yet adopted automation but have a desire to learn more about available systems.

Extraction and purification of DNA from forensic casework samples can be time consuming when performed manually. Increasingly, laboratories are looking towards automated robotic platforms to aid in the steps that can be easily performed by a robot, thus increasing overall laboratory efficiency while decreasing the chance of human error. In addition, forensic casework samples are regularly sent to the crime lab in a variety of formats, such as swabs, or pieces of fabric, and may contain a variety of PCR inhibitors that need to be removed prior to short tandem repeat (STR) amplification.

Promega has developed the DNA IQ™ Casework Sample Kit for Maxwell™ 16, which utilizes DNA IQ™ resin in a pre-filled cartridge format. The DNA IQ™ System chemistry has been well established in the forensic community with regards to its ability to produce final DNA extracts that are free of PCR inhibitors, but up until recently has only been used in a manual format or in a high-throughput platform designed to process up to 96 samples at one time. The Maxwell™ 16 instrument is a paramagnetic particle handling robot designed to extract from 1-16 samples at one time with no wasted reagents if the full throughput of the instrument is not utilized, an issue that is common with most high-throughput platforms. The efficient magnetic particle processing of the Maxwell™ 16 instrument avoids other common automation-related issues such as clogged tips or partial reagent transfers that can result in sub-optimal DNA extracts. Methods for extraction of forensic casework samples have been optimized by Promega and are included on the instrument. No additional computer or knowledge of robotics programming is necessary to utilize the system.

The DNA IQ™ Casework Sample Kit has been designed specifically for extraction of DNA from sample types commonly encountered in forensic casework, such as blood stains, touch or trace DNA samples, and tissue. In addition, the system concentrates the final DNA extract in to a volume that is optimal for forensic casework. The authors will provide data regarding extraction of these and other sample types, including comparisons of DNA yields obtained from the Maxwell™ 16 System vs. other robotic platforms. Demonstration of the viability of the final DNA extracts for downstream STR typing applications, and customer testing of non-probative casework samples will also be presented.

DNA Extraction, Maxwell 16™, Forensic Casework DNA Samples

B203 The Hamilton Star: A New Platform for DNA Analysis

Kristen Hancock, BS, The Bode Technology Group, 7364 Steel Mill Drive, Springfield, VA 22150; and James W. Schumm, PhD, The Bode Technology Group, 10430 Furnace Road, Suite 107, Lorton, VA 22079*

After attending this presentation, attendees will understand the advantages and disadvantages of use of different automation systems for the laboratory processes required to generate STR profiles from databank or casework evidence.

This presentation will impact the forensic community and/or humanity by demonstrating how those who follow the advice and protocols presented will increase their ability to solve large numbers of crimes quickly by generating DNA profiles for database searching and casework.

Over the past several years, DNA typing in the forensic community has flourished. With new laws being passed, government funding has created an abundance of samples and an increasing variety of sample types to be processed. New technology and new funding has stimulated public laboratories to re-open old cases and to work on backlogs and no-suspect cases. Nowhere are the effects of these changes felt more intensely than in private laboratories that assist the public laboratories, each with their own specialized needs and requirements. This variety of sample materials and the increase in sample numbers to the hundreds of thousands has demanded improvements in the efficiency of sample processing.

New bottlenecks in sample processing occur with every new process improvement. In these laboratories, a LIM system is being expanded to limit paperwork and to assist with sample tracking, freeing up some analyst time, and preventing QA incidents. Expert systems are being tuned and upgraded to eliminate additional analysis time. When the combination of these two systems is fully implemented, the new bottleneck will be the actual processing of the samples in the lab.

Many of the forensic processes currently used are easily automated with robotic liquid handlers. While Bode is not new to the field of automation, the need to incorporate new technology to increase both sample throughput and the variety of sample types requiring automation, while decreasing the requirement for analyst time spent, has become evident.

Several automated systems were evaluated with respect to pre-amplification processes such as DNA extraction, quantification, normalization, amplification, and cherry picking. The Hamilton Star system was selected because it includes high-throughput capabilities, cross-contamination prevention, barcode tracking capabilities, excellent precision, and significant process flexibility. This choice also supports the need for adaptable software to process samples according to many different client specifications regarding plate maps, sample types, sample numbers per plate, and various STR multiplex kit selections with a minimum of re-programming.

Development and validation of automated processes for DNA IQ extraction, DNA normalization of extract concentrations, and PCR set up protocols have been developed. The advantages that the Hamilton instrument brings to these processes and the improvements in laboratory efficiency provide a way to meet the increasing demands for DNA profiling in the forensics community.

Automation, STR Amplification, DNA Extraction

B204 Advances in Biochip-Based STR Analysis: A Rapid Field-Based Approach

Paul Pyzowski, BSEE, MBA, and Eugene Tan, PhD, Network Biosystems, 1 Gill Street, Suite B, Woburn, MA 01801*

After attending this presentation, attendees will be familiar with recent advances in biochip-based DNA analysis systems that enable STR analysis to be performed at a crime scene.

This presentation will impact the forensic community and/or humanity by demonstrating that DNA evidence can be analyzed at crime scenes in only a few hours. By doing so, STR data collected in real-time can be utilized to identify and apprehend suspects within days or hours of the commission of a crime. By apprehending suspects more quickly, the time and costs of criminal investigations would decline substantially. Even more importantly, rapid apprehension would limit recidivism, significantly improving public safety.

It has long been a goal of forensic scientists to analyze DNA evidence at crime scenes, reducing the time from discovery to a fully characterized short tandem repeat (STR) profile and impacting the investigation from its outset. Recently, this goal was achieved using Genebench-FX™ - a DNA analysis system built by Network Biosystems – demonstrating that DNA evidence could be collected and analyzed at crime scenes within four hours, in one case leading to an arrest forty minutes later.

The primary challenge in bringing biochip-based DNA analysis tools to the forensic community has been in developing a robust, commercial instrument that offers reliable and reproducible performance when operated in the field by forensic lab personnel.

Genebench-FX™ uses a biochip for separation of DNA fragments. Genebench-FX™ accepts samples of extracted DNA that have been amplified and prepared with a commercial STR kit, and identifies the alleles present in the sample(s). The system is designed to be readily transported to and operated in the field. The mechanical chassis includes special features to protect the optical system during transport. The run time temperature of the matrix is held to within a degree even with wide swings in ambient temperature. Additionally, the system only requires power from the equivalent of one standard 120V/240V outlet, so it can be readily deployed in mobile operations.

Operating data will be presented that demonstrates that the system meets or exceeds all requirements for analysis of STRs with respect to both technical operation and reproducibility. This includes:

- Representative data from both CODIS and European commercial STR kits
- Resolution of rare single-base alleles (e.g. TH01) without increased analysis times
- Sensitivity to a wide range of DNA template concentrations, including extremely low concentrations
- Inter- and intra-run precisions of between 0.1 and 0.25 bp

The presentation will discuss the challenges – technical and logistical – in implementing a mobile DNA forensics lab, based on experiences implementing such a system with an actual forensics lab. It will also highlight areas where continuing developments will further enhance the ability of biochip technologies to impact forensic investigations.

DNA Typing, Short Tandem Repeats (STRs), Polymerase Chain Reaction (PCR)

B205 Microfluidic Systems for Forensic Genetic Analysis

Joan M. Bienvenue, MS, Lindsay A. Legendre, BS, James M. Karlinsey, BS, Christopher J. Easley, PhD, Katie M. Horsman, MS, Jerome P. Ferrance, PhD, and James P. Landers, PhD, University of Virginia, Department of Chemistry, McCormick Road, Charlottesville, VA 22904*

After attending this presentation, attendees will understand the advancements being made in microfluidics towards the development of a fully-automated genetic analysis system for forensic casework processing.

This presentation will impact the forensic community and/or humanity by through the overview of some of the recent developments in the field of microfluidics and come away with a better understanding of the state of microdevices for forensic applications.

Over the past several years, developments in microfluidic technology advance us toward a full microscale integration of the processes associated with genetic analysis. En route to such a device, the ever-increasing complexity of the microdevices is matched only by the ever-improving capabilities of these microchip systems. Nanoliter pumping, on-chip valving, and novel passive flow control now enable precise sample manipulation and highly controlled fluidic handling in these systems. These advances have allowed for the drastic reduction of the time required for analysis, the volume of reagents consumed, and the cost associated with performing a wide variety of sample processing steps (including DNA extraction, PCR amplification and the separation and detection of target amplicons) and, recently, a single integrated microchip capable of accomplishing all of these analysis steps in less than 30 minutes has been reported.¹ In addition to their probable application to clinical diagnostics, microdevices are becoming an increasingly more viable option as a rapid and cost-effective method for improving forensic DNA analysis. In fact, inexpensive glass microchips are already being developed and evaluated in forensic laboratories to improve the efficiency, reproducibility, and automation of current time-consuming bench-top processes. As a result of these advancements, multi-component microfluidic genetic analysis has been realized.

The research presented here describes the recent progress made towards the development of microfluidic systems for forensic genetic analysis. It will highlight the current advancement of device design and methodologies for a variety of sample processing steps, including cell-sorting, PCR amplification, and separation and detection of PCR products. The devices and associated methods presented exploit elastomeric valving systems for precise fluidic control of solution flow throughout the device, allowing on-chip pumping and multiple process isolation. Novel techniques for DNA extraction and cell sorting are described and results from rapid, non-contact, IR-mediated PCR amplification of STR fragments are also presented. In addition, a multi-color detection scheme for microfluidic STR analysis will be described. Methods for integrating sample processing steps for the analysis of STRs from forensically relevant samples are discussed, highlighting integrated SPE-PCR systems capable of interfacing with conventional laboratory instrumentation and novel approaches for carrying out chip-based differential extraction. The aim in presenting these research advances is to provide a more global understanding of integrated microfluidic systems to the forensic community so that development efforts yield functional microfluidic systems specifically tailored to forensic DNA analysis. As a result, the work reported here is meant to emphasize the flexibility of these devices and designs for both application and sample type, as well as provide a platform to engage the forensic community in facilitating the development of this new genetic analysis system.

Reference:

¹ Easley, CJ, Karlinsey, JM, Bienvenue, J.M., Legendre, L.A., Roper, M.G., Feldman, SH, Hughes, MA, Hewlett, EL, Merkel, TJ, Ferrance, J.P. and Landers, J.P. "A Fully-Integrated Microfluidic Genetic Analysis System with Sample in-Answer out Capability". PNAS (in revision).

Microchip, DNA, Integration

B206 Towards the Integration of Cell Separation With Solid Phase Extraction on a Single Microfluidic Device

Jessica C. Voorhees, MSc, Kate Manning, Susan L.R. Barker, PhD, Jerome P. Ferrance, PhD, and James P. Landers, PhD, University of Virginia, Department of Chemistry, McCormick Road, Charlottesville, VA 22904*

The goal of this project is to integrate the separation of sperm cells from epithelial cells with subsequent on-chip DNA extraction from each cell fraction on a single microdevice. The extracted DNA from each cell type is compatible with subsequent STR analysis.

This presentation will impact the forensic community and/or humanity by presenting work that represents a major step towards the development of a fully integrated microdevice capable of total DNA analysis for forensic casework.

Microchip technology offers the potential of a rapid, cost-effective alternative to conventional DNA analysis methods. The research presented will highlight the development of integrated microdevices that combine cell separation and solid phase extraction (SPE) of DNA from the separated cells, two of the procedures necessary for analysis of sexual assault evidence where male and female DNA must be separately identified/interrogated. This presentation will demonstrate the application of microchip technology to forensic casework analysis, illustrating the significant potential impact these devices might have on the forensic community.

The proven utility of forensic DNA evidence has increased the demand for DNA analysis services. Although conventional DNA analysis techniques are effective, they are time-consuming and laborious, which has contributed to an overwhelming backlog of forensic casework samples with possible biological evidence. Research efforts have focused on the development of more rapid and efficient analytical methods, as well as the automation of existing methods, to reduce the time and cost of forensic analysis as well as the magnitude of the existing casework backlog. Techniques performed on microchips are particularly advantageous because they can be integrated with upstream or downstream analytical steps on a single microfluidic device in the form of a lab-on-a-chip or micro-total analysis systems (μ TAS). These integrated systems, which incorporate all the sample processing steps required for forensic DNA analysis, will reduce analysis times, and therefore, the forensic casework backlog. Successful microchip methods for separating sperm and epithelial cells have previously been demonstrated^{1,2} These methods circumvent the most time-consuming step in DNA analysis of sexual assault evidence, the conventional differential extraction procedure. In addition, microchip-based SPE has previously been demonstrated³ on a variety of biological materials.

The research presented here describes efforts towards integration of cell sorting and solid phase extraction of DNA on a single microdevice. The functionalities of the device are described, including the results of PCR amplification of STR fragments from genomic DNA isolated from cells sorted based on their physical properties. The sperm and epithelial cells were lysed on-chip in their separate areas, followed by isolation and purification of their respective DNA fractions; DNA amplification

and separation were performed using conventional laboratory methods. Preliminary work on a second cell separation method, based on capture of cells using acoustic trapping (2) is also presented, along with initial attempts toward integration of this method with on-chip SPE. The presented work represents a major step towards the development of a fully integrated microdevice capable of total DNA analysis for forensic casework.

References:

¹ Horsman KM, Barker SLR, Ferrance JP, Forrest KA, Koen KA, Landers JP. *Anal Chem* 2005; 77:742-749.

² Peat M, editor. *Acoustic differential extraction: a novel alternative to conventional differential extraction*; 2006 Feb 20-25; Seattle. Seattle: American Academy of Forensic Sciences, 2006.

³ Bienvenue JM, Duncalf N, Marchiarullo D, Ferrance JP, Landers JP. *J Forensic Sci* 2006;51(2):266-273.

DNA, Solid Phase Extraction, Cell Separation



C1 Conventional Surveillance is Adaptable to the IP Camera and the IP Eavesdropping of Security (Countermeasures)

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After attending this presentation, attendees will understand that the webcam is becoming a criminal tool for remote monitoring and will recognize that conventional equipment is still useful to overcome the application of new technology for webcam surveillance.

The webcam uses the Internet and the Wireless LAN so popular today, and it is a convenience to connect people. Reversely, it threatens security. No one is an exception to violation of personal privacy, especial to VIPs and governmental officials. This presentation will impact the forensic community and/or humanity by demonstrating how this is becoming a considerable issue to the forensic community.

The Internet has been developed as a worldwide communication network and it is almost extended to anywhere of the world. Furthermore, Bluetooth technology and wireless LAN are built easily and are commonly available. In the past invaders, for some specific reasons, had to combine few electronic components for assembling a covered device as a spy tool in order to monitor activities or to listen to conversations of someone at a hidden place. In principle, the components include the sensors (pin-hole camera or small microphone) and transmitter (the simplest one is a cable only, or various RF modulation modules). Then the signal is transmitted to the receiver. As a mature technique today, to check and find those suspected devices using advanced detection equipment will not be a problem.

Relatively, as the Internet becomes a popular communication tool of transporting multimedia message, it is easier to do the same illegal action than before. An offender is easily able to remotely monitor the activities of others because spy camera and eavesdropping have been migrated to webcam as new tools to violate privacy and human right as well as causing criminal behavior. This paper intends to describe some efficient methods in finding illegal webcams and providing a guideline to search for hidden webcams or bugs via conventional detection equipments.

The context of this paper will focus on the portion of the sensors for detection and surveillance rather than paying too much attention to the portion of signal transmission. By means of this paper, the authors would like to remind readers (especial forensic persons) about emphasizing the inspection to the suspected webcam with microphone device. It is important to regulate any computer system with a capability of internet connection (wire line or wireless) shall not be allowed for a confidential meeting. For example, an advanced model of notebook PC is a particular one used for doing a spy job, but it is neglected from security inspection. The task of counter-measurement shall rely on high-tech measuring equipment but also depends on the skill to recognize what are some potential resources of insecure accessories.

The purpose of this study is to eliminate a puzzle about counter-measurement for the challenge to the illegal application of webcam with wires or wireless transmission.

Web Camera, Countermeasure, PC

C2 Cause of Failure of a Bungee Cord

Ming Kiong Michael Tay, PhD, Chin-Chin Lim, MSc, MBA, Wanjing Su, Soon Meng Wong, Poh Ling Chia, BSc, Centre for Forensic Science, Health Sciences Authority, 11 Outram Road, Singapore, Singapore 169078, Singapore*

After attending this presentation, attendees will learn how the failure of a bungee cord was investigated in a laboratory and foul play was ruled out as cause of the sudden rupture.

This presentation will impact the forensic community and/or humanity by showing how a damaged bungee cord was examined and the causes of failure of the cord were determined.

After attending this presentation, attendees will learn how the failure of a bungee cord was investigated in a laboratory and foul play was ruled out as cause of the sudden rupture.

This presentation will impact the forensic community and/or humanity by showing how a damaged bungee cord was examined and the causes of failure of the cord were determined.

During tensioning of the cords in a reverse bungee machine in preparation for a launch, one cord suddenly snapped. The damaged cord was alleged to be within its life span. The question arose whether someone had tampered with the cord, resulting in its premature failure. Investigators submitted the following exhibits for laboratory examinations: the two lengths of the damaged cord, the corresponding unbroken cord on the other side of the carriage, a newly bound cord (control sample), and a control sample of black elastic ribbon.

Construction of cord: The bungee cord had a white hard plastic bobbin at each of its two attachment ends. The bungee cord consisted of a bundle of many black elastic ribbons bound by similar black elastic bands stretched spirally over the thick bundle. The spiral bindings criss-crossed in opposite directions of twist (clockwise and anti-clockwise), holding tightly together the bundle of ribbons. The ends of the spiral bindings were knotted together. The broad ribbons were made of black elastic strands joined side-by-side lengthwise. The elastic material was made of vulcanised carbon black-filled cis-polyisoprene (natural rubber) with some silicone oil coating. The cord was protected by a blue cloth sleeve (sheath), woven from a blend of polyamide (nylon) fibres and polyether urethane fibres (lycra-like). This highly elastic flexible material provided a protective sleeve that "hugged" the black elastic cord but was able to accommodate the longitudinal stretching and radial expansion of the cord.

Questioned damaged cord: The two lengths of cords with the bobbins weighed 40.3 kg. The two lengths of broken cord were 7.31 m, and 3.13 m long, respectively. The ends of the black elastic strands in them were of varying lengths, indicating they were not cut but had torn under tension. The number of strands in the cord was approximately 4,268.

Damages on the blue sleeve: Some areas of the blue sleeve had thinned out due to stretching, abrasion and wear-and-tear. Throughout its length, the blue sleeve had circular dirt marks and thinned bands around the circumference of the cord, corresponding to the bindings around the cord. The sleeve was double-stitched along its length; some seams had burst. The sleeve was found to be torn and burst due to the elastic strands enclosed within in it pulling back (rebounding) when the cord snapped. Beneath the blue sleeve were many lumps due to loops of black elastic strands forming between the spiral bindings. However, there was no evidence on the blue sleeve of cuts by a sharp cutting object or instrument.

Damages on the black elastic cord: The damaged ends of the two lengths of cord had many broken ends of varying lengths; some long and some short, in a tangle. The spiral black elastic bindings were not damaged. Many of the exposed ribbons had split length-wise into separate individual strands. SEM examination revealed cracks on the surfaces of many strands, and fracture at the ends due to tension, with evidence of elongation past breaking point. The damages indicate that the sudden break in the cord and release of the load immediately caused the stretched strands to spring back, gathering as loops between the spiral bindings. This led to a sudden radial expansion or increase in diameter, which burst the blue sleeve in certain areas. Removal of the blue sleeve revealed numerous black rubber strands in the cord with broken ends, and loops of strands between the spiral bindings. Removal of the spiral bindings to expose the interior of the bundle revealed about 875 broken strands in one 0.5-metre section.

Cord on the other side of the carriage: It was 9.30 m long and had a diameter ranging from 26.7 cm to 30.0 cm. Grey stains and thinned-out areas were found on the blue sleeve, and some parts of the seams had burst. Lumps could be felt beneath the sleeve. Numerous black rubber strands in the cord had broken ends, and numerous loops of strands between the spiral bindings. Removal of the criss-crossing spiral bindings in a 0.5-metre section revealed about 300 broken strands in a 0.5-metre section.

Test damages: Test damages were created on control elastic strands by stretching until breakage, cutting with a utility knife (box-cutter) with and without tension in the strands, and cutting with a pair of scissors with and without tension in the strands. The ends of the test damages were compared with those of the questioned cord.

Conclusions: The black elastic strands of the bungee cord and its blue sleeve were not cut by a sharp cutting instrument or object. The damages were consistent with failure and fracture of the bundle of rubber strands in the cord due to ageing, tension (stretching) and fatigue. Environmental factors can affect both the short- and long-term fatigue behaviour of rubber. Detrimental factors include: elevated temperatures, oxidative ageing by oxygen and ozone, other chemical attacks, ultraviolet light and sunlight, and repeated mechanical stresses. Fatigue life is also affected by the presence of unintentional uncontrolled flaws introduced at any stage of the manufacturing process of rubber.

Bungee Cord, Elastomer, Fracture

C3 Fundamental Research on Evaluation of Impact Load by Hit

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After attending this presentation, attendees will understand the suitable measuring method of the impact loads of a hit.

This presentation will impact the forensic community and/or humanity by demonstrating the importance of considering an assault incident dynamically.

Recently, many incidents in which a human body receives a hit with a bat etc. have occurred. Therefore, at the court, the scientific data of the hit force produced with a weapon is needed. However, hit force has many parameters, such as average value, maximum, and action time, and is difficult to quantify. Then, the hit experiments were conducted using metal baseball bats, wooden swords, and aluminum pipes. During the experiments, impact load was measured by load cells, and hit speed was measured from high-speed video images.

This research considered the evaluation method of impact load using the maximum of impact load, impact energy, and hit speed. Moreover, the authors also investigated the influence of soft tissues, such as skin, on the damage that human bodies receive.

As a result, the authors were able to acquire the following knowledge.

- (1) The maximum of impact load is proportional to hit speed.
- (2) Even with different hit methods, if hit speed is the same, the impact load that a human body receives is comparable.
- (3) The quality of the material and thickness of soft tissue, such as the skin, affect both the size and action time of impact load.
- (4) There is a close resemblance between the kinetic property over the impact load of commercial cell sponge, and that of soft tissue.
- (5) By putting in cell sponge between a load cell and a hitting instrument, a load equivalent to the impact load, which an actual human body receives, is measurable.

Impact Load, Hit Force, Cell Sponge

C4 Characterization of Seat Belt Webbing Loop Energy Absorption Properties

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After attending this presentation, attendees will have a list of modern vehicles that utilize energy absorption (EA) loops in their occupant restraint design. The attendee will also learn the force v. elongation and energy v. elongation properties for a sample of current belt designs.

This presentation will impact the forensic community and/or humanity by providing the forensic community heretofore unpublished energy absorption properties of EA loops. This will allow the forensic investigator to determine force levels applied to belts that incorporate these designs. It will also provide some insight into their behavior for those concerned with occupant kinematics and overall restraint effectiveness.

Proposition: A survey of late models vehicles will be conducted to determine which vehicles have webbing loops sewn into the lap belt portion of the restraint. Several belts will be tested to determine quasi-static elongation at known force and displacement.

Synopsis: A sample of belts from the above survey will be procured from the used market and tested. The test will be a quasi-static pull of the portion of the webbing that contains the loop. Force and displacement will be collected and presented as force v. elongation and energy v. elongation curves.

Summary/Conclusion: Reliable, repeatable testing of seat belt assemblies was performed to establish baseline data of force levels required to create known levels of seat belt deformation. This data will provide new information that can be used to determine occupant belt loads in motor vehicle crashes. Combination of this information with anticipated loads during various crash types (frontal, rollover, etc.) will allow other researchers to explore the safety implications of this type of energy management device.

Occupant Restraint, Seatbelt, Seatbelt Slack

C5 End-Release Buckle Shock Testing

William H. Muzzy III, BSME, WHMuzzy Consulting, 1509 Porter Avenue, Ocean Springs, MS 39564; Eric L. Van Iderstine, MSME, PE, McSwain Engineering, Inc, 3320 McLemore Drive, Pensacola, FL 32514; and Lamar Tillery, BA, McSwain Engineering, Inc, 3320 McLemore Drive, Pensacola, FL 32514*

Certain end-release safety belt buckles experience un-commanded unlock and unlatch during motor vehicle accidents. The goal of this presentation is to describe a simple method of finding the susceptibility of these end-release safety belt buckles to unlatch due to vertical acceleration. This hypothesis was tested to confirm that these buckles do exhibit un-commanded unlock and can and will unlatch in real-world rollover collisions.

This presentation will impact the forensic community and/or humanity by demonstrating When a seat belt restraint is found to be unlatched after a vehicle rollover event or a vehicle has sustained an upward vertical impact the authors recommend that accident investigators inspect the buckle design and its mounting method to find out if shock-related buckle unlatching occurred.

Certain end-release safety belt buckles experience un-commanded unlock and unlatch during motor vehicle accidents. This presentation describes a simple method of finding the susceptibility of these end-release safety belt buckles to unlatch due to vertical acceleration. This hypothesis was tested to confirm that these buckles do exhibit un-commanded unlock, and can and will unlatch in real-world rollover collisions.

The analyzed buckle is a common end-release buckle design described in U.S. Patent 4,575,907 issued on March 18, 1986. This buckle design has a sliding plate described as a “slideable control member,” which is “engaged between a portion of frame and the latch portion to positively lock the latch plate in the latched position.” In this design, a spring-actuated sliding plate sits atop a pivoting latch. In the unlatched position, two projections on the frame sidewalls limit upward movement of the sliding plate. When the latch plate is inserted, the latch pivots into a rectangular hole in the latch plate. This frees the spring-actuated sliding plate to move upward beneath the same two frame projections and, according to the patent, “positive locking of the [latch] in the latched position is very simply accomplished.” A tension spring attached to a bent arm on the latch accomplishes engagement of the sliding plate. When the latch plate is inserted, and the sliding latch plate is sandwiched between the latch and the frame projections, this tension spring is fully relaxed.

There are three methods of attaching safety belt buckles to a vehicle’s structure: cable, webbing, and rigid element. Of the three, the rigid element transmits the most shock upward from the vehicle during a rollover or when an object strikes the vehicle’s frame from underneath. The analyzed buckle design is from a vehicle using the rigid element attachment method.

An upward acceleration transmitted to the buckle frame allows the sliding plate to move downward with respect to the frame, unlocking the latch. This can allow the latch to pivot into the unlatched position, releasing the latch plate. To prove this, a drop fixture consisting of a sliding carriage spanning two vertical linear shafts was constructed. Elastometric pads beneath the carriage were used to shape the acceleration pulses, and a data acquisition system was used to record the shock pulses.

Each exemplar buckle, with latch plate inserted, was bolted in its normal position with respect to the test carriage. The buckle-mounting tang was vertical, allowing the buckle body to tilt inward (toward the occupant) by about 8 degrees. This represents the as-built configuration in a vehicle.

There were 446 tests with drop heights that produced approximately 8-millisecond total pulse lengths with maximum accelerations that ranged from 166 g peak at 2.9 m/s to 347 g at 4.25 m/s

resulted in latch plate release for 120 tests. Different drop heights and elastometric pads with varying hardness also resulted in latch plate release.

A matrix of drop heights, buckle angles, and acceleration impulses using 20 buckles gives a range of conditions at which this buckle design will release. High speed video of tests with the buckle mechanism revealed show how the sliding plate moves downward, unlocking the latch.

When a seat belt restraint is found to be unlatched after a vehicle rollover event, or a vehicle has sustained an upward vertical impact, the authors recommend that accident investigators inspect the buckle design and its mounting method to find out if shock-related buckle unlatching occurred.

Buckle, Unlatch, Shock

C6 Passenger Seat Belt Forces During Ordinary Driving

Robert D. Anderson, MS, Biomechanics Analysis, PO Box 7669, Tempe, AZ 85281-0023*

After attending this presentation, attendees will learn objective data regarding the magnitude of seat belt forces encountered during ordinary driving maneuvers and passenger movements. The usefulness of this data will be demonstrated in the evaluation of a potential seat belt buckle false latch problem through a case study.

This presentation will impact the forensic community and/or humanity by providing useful objective data on realistic seat belt forces than can be expected to be encountered in passenger seat belts during ordinary driving maneuvers and occupant movements. This data can be used to evaluate the performance or identify limitations to certain seat belt designs.

The restraining force for which the seat belt is designed to provide in a collision is well understood. However, there is little, if any, available data regarding the seat belt forces encountered in during everyday vehicle maneuvers. The measurement and the magnitude of seat belt forces encountered during ordinary driving will be presented. The usefulness of this data will be demonstrated in the evaluation of a potential seat belt buckle false latch problem through the following case study.

The left rear tire of an SUV traveling on an interstate delaminated causing the vehicle to yaw and leave the roadway where it rolled over three or more times before coming to rest on its wheels. The driver and front passenger seat belt use was confirmed by loading marks on the plastic covered latch plates. Less prominent loading marks on the rear passenger seat belt supported the front occupants unwavering accounts that the rear seat passenger was also seat belted. However, the rear seat occupant sustaining fatal head injuries when she was fully ejected during the rollover.

A false latch syndrome may be described as a condition that the buckle is either not latched or not completely latched even though the latch plate is physically inside the buckle. This can lead to the occupant perception that they are seat belted when in reality a seat belt force far below a restraining force would detach the latch plate from the buckle, leaving the occupant effectively unrestrained. Given the adamant accounts of seat belt use by the survivors and the evidence of seat belt loading, the possibility of a seat belt buckle false latch was investigated.

Researching the National Highway and Traffic Safety Administration’s (NHTSA) consumer complaint’s database for this year make and model of SUV revealed 13 separate complaints of seat belts unexpectedly releasing while driving, failing to stay buckled, or unbuckling during a collision. Each of these complaints is consistent with a false latch syndrome. It is noted that according to Mitchell Collision Estimating Guide, this SUV was essentially unchanged over

the 1995 to 2001 model years. However, the seat belt buckles were changed after the first year. In fact, due to the number and presumably the consistency of complaints, NHTSA opened a defect investigation regarding this SUV for buckle releases.

Inspection of the subject vehicle and its seat belts revealed that the side latch buckle spring was sufficiently stiff to hold the latch plate in place, even though the latch plate was not actually locked in place. As shown in Figure 1, using a seat belt tension transducer pulling straight up on the shoulder belt required approximately 25 pounds of shoulder belt tension to separate the unbuckled latch plate from the buckle. Preventing the webbing from passing through the latch plate, effectively eliminating wedging within the buckle, the shoulder belt tension required to separate the unbuckled latch plate from the buckle was found to be approximately 5 pounds.

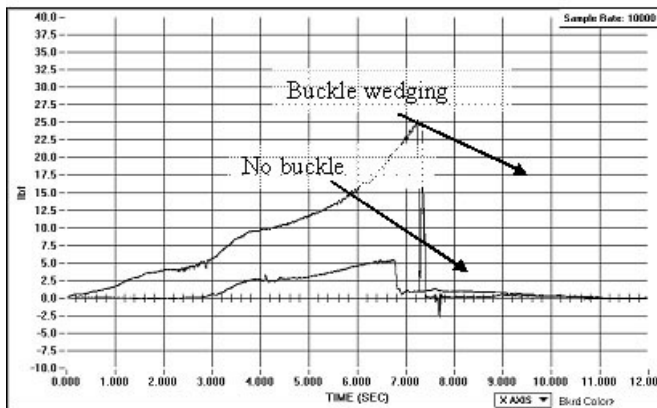


Figure 1. Shoulder belt tension to separate the buckle without occupant

With a person within the seat belt, lesser shoulder belt tension forces would be expected since the latch plate would be pulled by both the lap belt and the shoulder belt similar to a pulley. Indeed, using a model much larger than the rear seat occupant, the shoulder belt tension required to separate the unbuckled buckle within the range of 3.4 to 4.2 pounds was measured. Due to the increase in wedging within the buckle, greater shoulder belt tension would be expected for a smaller occupant.

To assess the magnitude of ordinary seat belt forces experienced during normal use in a vehicle, a preliminary study was conducted with an 11 year old male and a 15 year old male seated in the right front passenger seat of a Toyota Sequoia. A RA Denton model 6400 seat belt tension transducer was utilized with a TDAS Pro collecting at 10 kHz. As shown in figure 2, backing off a rounded curb, accelerating, stopping, turning, and running over speed humps, the shoulder belt forces rarely exceeded 3 pounds. During both demonstrations, shoulder belt forces were less than 3.2 pounds, even when the subjects were asked to lean forward a couple of inches.

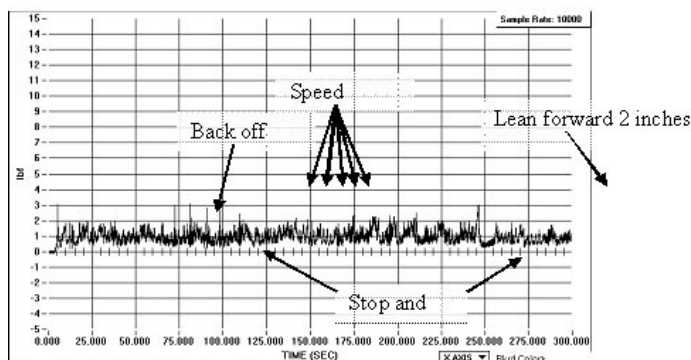


Figure 2, shoulder belt tension 11 year old male passenger

Figure 2. Shoulder belt tension 11 year old male passenger

Therefore, it would appear that even if the shoulder belt forces to separate an unlatched buckle were as low as that measured using an over-sized model, it would not be unreasonable to expect that an unlatched buckle could hold the seat belt on an occupant for some period of time, provided that there was not any unusual roadway obstacles, unusual vehicle maneuvers, or unusual occupant activities. Other possible mechanisms for seat belt release, such as inertial release were not investigated in this case.

The current study provides a useful objective data point for realistic seat belt forces than can be expected to be encountered in passenger seat belts during ordinary driving maneuvers and occupant movements. The above case study demonstrates the potential utility of seat belt tension measurements taken outside the crash environment in the evaluation of certain of restraint issues.

Seatbelt, Tension, False-Latch

C7 Dynamic Testing of Guardrails and Vehicle Fuel Systems: Discovery of New Hazards and Development of Alternative Vehicle Fuel System Designs

Mark C. Pozzi, MS*, Sandia Safety Sciences, 2 Marietta Court, Suite A, Edgewood, NM 87015

After attending this presentation, attendees will understand the correct interpretation of forensic evidence cross-correlates with similar vehicle and guardrail damage shown during controlled dynamic experimental tests. A nationwide roadside hazard was discovered which was not previously recognized.

This presentation will impact the forensic community and/or humanity through the implementation of the scientific method to identify the source of failure in the subject vehicle, development of objective testing to identify not only the failure mode but also to validate alternative fuel system designs. The foregoing process identified a public safety hazard that existing research and development and the formal Department of Transportation certification testing had not revealed.

The goal of this presentation is to present detailed information from a field collision investigation, combined with a series of experimental crash tests which were conducted to determine potential hazards of guardrail appliances, and potential alternative vehicle fuel system designs.

Forensic investigation of a post-collision vehicle fire revealed unusual damage to the fuel system. The only object in the environment that could have been responsible for penetration of the fuel system was a component of the guardrail end. The guardrail end appliance is considered a "state-of-the-art" safety device. Research indicated that the guardrail end had been dynamically tested via frontal vehicle impacts, but not in rear impacts. Thousands of these guardrail ends have been installed throughout the U.S.; therefore this is a prevalent hazard.

A series of dynamic crash tests with exemplar vehicles was conducted under controlled, repeatable conditions at the same or higher velocities than the impact by the subject vehicle. A new, identical guardrail and end appliance was installed per manufacturer specifications. One vehicle was modified with a fuel tank shield to protect the OEM fuel system. Another vehicle was modified with a production trunk-mounted fuel tank from an earlier model vehicle produced many years earlier by the same manufacturer. The vehicle trunk was modified with a full firewall and improved structural elements, as well as improved trunk lid retention. The vehicles impacted the guardrail at the rear centerline. New replacement guardrail was installed for each collision. Collision damage and fuel system integrity was documented and analyzed.

Results of the testing revealed a consistent hazard created by the guardrail end appliance and attachment hardware on the subject vehicle and both test vehicles, although fuel leakage was prevented due to the alternative designs. The testing proved there were reasonable, technically and economically feasible alternative designs that would have prevented the fuel system leakage under the same or more severe impact loading than occurred in the subject collision. Reasonable, technically and economically feasible designs could also attenuate the hazards posed by the guardrail end appliance. The guardrail end appliance hardware should be modified by shielding of protruding structures, or modification of attachment hardware to reduce force-concentrating structures.

Guardrail, Rear-Impact, Fuel System Integrity

C8 Visibility Reconstruction of Nighttime Collisions: Correcting for Investigator Bias

James B. Hyzer, PhD, Hyzer Research, 1 Parker Place, Suite 330, Janesville, WI 53545-4077*

The goal of this presentation is to provide the attendee with insight into how visibility-distance data obtained from nighttime site observations and/or a reenactment of the collision should be interpreted when used to model or predict what the driver involved in the subject collision should reasonably be expected to have perceived.

This presentation will impact the forensic community and/or humanity by providing a better understanding of investigator bias associated with visibility reenactments and the scientific basis by which to account and correct for such bias.

The objective of this paper is to describe, validate, and expand upon a published methodology¹ for reconstructing the visibility aspects of nighttime collisions between a vehicle and a roadway hazard such as a pedestrian, object, or obstruction, appearing ahead under headlamp illumination. The outcome will be to provide the attendee with insight into how visibility-distance data obtained from nighttime site observations and/or a reenactment of the collision should be interpreted when used to model or predict what the driver involved in the subject collision should reasonably be expected to have perceived.

The goal of a forensic visibility reconstruction is typically to determine a statistically valid distance by which reasonably alert drivers should have perceived and responded to visual signals that preceded a nighttime collision. If a nighttime reenactment is performed, then clearly, the investigator who is reenacting the event, even under substantially similar conditions, has many visual and other advantages over the driver who was involved in the actual event being reenacted. Among them, the investigator has the advantage of knowing, *a priori*, what to look for, where to look, and, not having the burden of also driving the vehicle, has plenty of time to search for and detect the exemplar pedestrian or hazard. Consequently, the visibility distance an investigator determines by reenactment will be significantly biased toward being greater than what should be expected of most alert drivers under the dynamic conditions of the real-world encounter and collision to which he was subjected. Therefore, to be reliable it is necessary to correct the investigator's experimentally derived visibility distances to reflect what a statistical sample of typical drivers should be expected to visually experience.

A methodology for interpreting reenactment and post-collision observational data will be described along with the science and statistics upon which it is based. Limitations and typical applications will be discussed. In shortcut form, and with simplifying assumptions that must be understood, after reenactment visibility distance observations are made the method basically involves the following steps: First, the observed visibility distance of the reenactment is multiplied by two thirds (2/3) to approximate the distance that would be expected of the

average driver in a structured test. Second, that mean distance is multiplied by one half (1/2) to account for driver expectancy. Third, the standard deviation about the mean is determined by multiplying that distance by one third (1/3). And lastly, the mean distance may be further reduced to account for the age of the driver and other typical attenuating factors by an amount that will be described.

It is important to recognize that this shortcut method is an approximation and is based on many assumptions that must be taken into account. One assumption is that the brightness of a headlamp-illuminated object in the roadway is inversely proportional to the distance between the vehicle headlamps and the object. In many typical low-beam nighttime driving situations this is not the case and the statistical visibility distance calculations must be determined instead as a function of object luminance and/or contrast. The details and consequences of this and other assumptions will be discussed.

The impact of this presentation will be to provide a better understanding of investigator bias associated with visibility reenactments and the scientific basis by which to account and correct for such bias.

Reference:

¹ Forensic Aspects of Driver Perception and Response, Second Edition, Paul L. Olson and Eugene Farber, Lawyers & Judges Publishing Company, Inc., 2003, pages 153-154 & 295 (describes "shortcut" methodology attributed to Hyzer, W.G. and Hyzer, J.B.).

Visibility, Nighttime Visibility, Accident Reconstruction

C9 Comparison of Barrier Impact Crush and Vehicle to Vehicle Crush in Head-On Collisions

Peter Alexander, PhD, Raymond Smith & Associates, 4934 Wagontrail Court, Parker, CO 80134*

After attending this presentation, attendees will understand how to compare vehicle to vehicle and vehicle to barrier crashes in terms of comparable damage.

This presentation will impact the forensic community and/or humanity by making the NHTSA crash test data base more useful.

During an accident reconstruction, one is sometimes presented with the need to assess collision impact speed in a head-on collision, based solely on an examination of the damage to the vehicles involved. This examination may involve a direct inspection of the vehicles or a review of photographs of the vehicles.

In order to determine an appropriate vehicle to vehicle (VTV) impact speed, it is often helpful to consult the National Highway Traffic Safety Administration (NHTSA) crash test data base to find vehicle to barrier (VTB) crash tests involving the subject vehicles (or their sisters). This is done in order to compare vehicle crush and overall damage in the staged NHTSA crash test to the damage to the vehicles that are under investigation. The NHTSA database contains thousands of VTB and impactor to vehicle crash tests, but only a small number of VTV staged crashes. It has been observed that a higher impact speed is often required in a VTV crash to produce the same level of damage as in a VTB crash. The question addressed in this paper is, how does one convert from a VTB impact speed to the VTV impact speed required to achieve equivalent damage?

In this paper NHTSA staged crash tests involving eight different domestic and foreign vehicle models¹ were examined. Head-on (zero degree) crash tests were chosen from the NHTSA database for cases where both VTV and VTB crash results were available for the same vehicle or sister vehicles. Vehicle crush values were compared to the impact speed producing the crush. A barrier impact speed multiplier factor was derived for each VTV impact to achieve damage comparable to that observed in a VTB crash involving like vehicles.

The results are depicted in Figure 1. Each data point represents two crashes; a VTV crash and a VTB crash using like vehicles. The crush in the VTV crash is expressed as a percentage of the VTB crush. The VTV impact speed is calculated as a percentage of the VTB impact speed. The VTB speed multiplier required yielding comparable VTV crush is derived by dividing the crush percentage by the impact speed ratio. The uncertainty associated with each data point in Figure 1 is very small in the vertical direction, but ranges from 15% to 30% horizontally. This is because there can be 10% to 20% differences in staged crash crush values involving like vehicles at the same impact speeds.

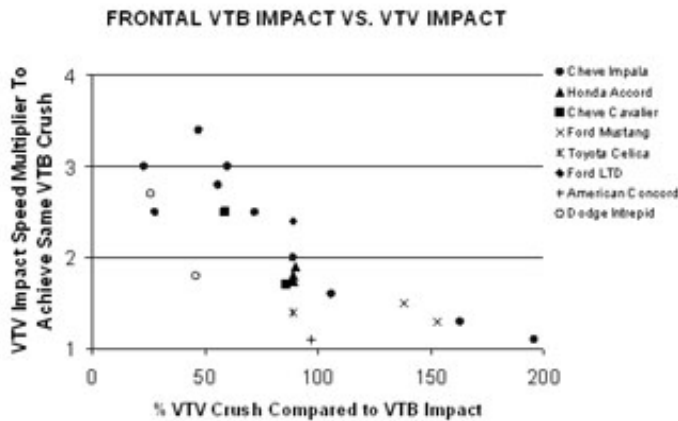


Figure 1

The trend of the data points in Figure 1 is as one might expect. A typical VTB impact speed is 35 m.p.h. VTV impact speeds in excess of 70 M.P.H. produce crush ratio values of 150% to 200% of the VTB crush. At these higher speeds the VTB speed multiplier approaches one. In other words at higher speeds (crush values) the VTB impact speed is the same as the VTV impact speed required to produce comparable crush. This is because the higher collision energy values involved overwhelm other factors that become important at lower crush values, as discussed below. It may be that different vehicles with different stiffness factors have multiplier factors that fall along families of best fit data curves.

At VTV impact speeds in the 20 to 25 M.P.H. range (crush ratio values of 25% to 50%), the VTB speed multiplier increases to a value of 2.5 to 3.5. This makes sense since it is known that some 5 m.p.h. IIHS² VTB crash tests produce damage, while the same vehicle does not experience damage in a VTV collision until the impact speed reaches 10 to 15 m.p.h. This is because the barrier does not carry off significant kinetic energy nor does it absorb significant energy through deformation. Thus the collision energy in a VTB collision is directed primarily into damaging the vehicle involved. In a VTV crash both vehicles can carry away kinetic energy in the form of post impact velocity and both vehicles can absorb energy in the form of crush. These effects are more pronounced at lower collision energy values than at higher values and can result in less vehicle damage in the VTV collision than in the VTB collision.

References:

¹ Chevrolet Impala 1978-1981, Chevrolet Cavalier 1982-1994, Honda Accord 1982-1985, Ford Mustang 1979-1993, Toyota Celica 1986-1989, American Concord 1980, Ford LTD 1979-1991, Dodge Intrepid 1993-1997.

² Insurance Institute for Highway Safety.

Barrier, Speed, Crush

C10 The “Critical Speed Formula” Revisited With Computer Simulations and a Sophisticated Math Model

Donn N. Peterson, MSME, PE*, Peterson Engineering, Inc., PO Box 664, Brainerd, MN 56401-0664; Donald J. Anderson, BSME, PE, Anderson Engineers, LLC, 13176 Pierce Street NE, Minneapolis, MN 55434

After attending this presentation, attendees will learn the influences of a variety of parameters on the error from using the common “critical speed formula” to estimate vehicle speed from measured curved tire marks on a roadway.

This presentation will impact the forensic community and/or humanity by quantifying the expected errors introduced by using the simplified “critical speed formula” for estimating vehicle speeds under a variety of operating conditions.

Background: Years ago a formula was derived, using many simplifying assumptions, to estimate the speed of a vehicle when it made tire marks in a turn or curve. The results can be a useful input in early stages of an accident reconstruction because they can provide “ballpark” values for a possible range for the vehicle speed.

Problems developed over the years because non-suspecting accident reconstructionists began to assign much greater accuracy to the speeds they calculated by using the simplified “critical speed formula” than they should. Such calculated speeds are often faster than the actual vehicle speed and may lead to erroneous conclusions about pre-crash speeds and a driver’s negligence

Several presentations have been given by AAFS members on this topic over the past decade. Some presenters gravely criticized use of the “critical speed formula” and others defended its use. Since truth is often somewhere between the extremes, the authors performed studies to provide an understanding of the effects and probable errors of some common factors that influence calculated results.

The authors used a version of the “3-D Math Model for Vehicle Dynamics Simulation Including Effects of Tires, Suspensions, and Terrain” published in the NAFE Journal DEC 1998. A presentation of which was first made by the presenting author in 1994 at the AAFS Meeting in San Antonio.

Accident Reconstruction, Speed Errors, Critical Speed Formula

C11 Observed Damage Patterns of Narrow Object Impacts

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The goal of this presentation is to show the unique damage patterns of a narrow object impact when the location of contact is moved from near centerline to a more eccentric location.

This presentation will impact the forensic community and/or humanity by identifying structural deformation as it relates to the location of the narrow object impacts relative to the distance from the vehicle centerline. This presentation will briefly describe each case, quantify the collision damage energy, and then detail the progression of case analysis.

The purpose of this presentation is to show the unique damage patterns of a narrow object impact when the location of contact is moved from near centerline to a more eccentric location.

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Introduction: Frontal traffic collisions produce unique vehicle deformation patterns that depend on the object that is struck. Oftentimes the investigating engineer can quickly determine what category of object was impacted based on the observed residual collision damage, because collisions with other vehicles, concrete walls, or trees will produce unique crush patterns. Impacts with narrow objects such as trees or utility poles create knife-like deformation patterns. Narrow object impacts often create deformation that penetrates deeper into the vehicle's structure when compared to an impact with an object that distributes collision forces over a greater width of the vehicle at the same speed. Induced damage is created when the vehicle wraps around the narrow object, and pulls the lateral components at the left and right inward.

The deformation pattern of two vehicles impacting trees will be presented. A damage energy analysis was used to determine the impact speed from the measured longitudinal collision damage and other scene information. The extent of vehicle damage and the subsequent structural compromises will be explored. The vehicle models in these two cases are the same and the vehicle weights are similar, but what is different is the location of the tree impact relative to the vehicle centerline. In the first case, the tree impact location is inches to the left of the vehicle centerline, whereas in the second case, the tree impact location is at the extreme left end of the bumper.

Collision Overview: The first case concerns a 1988 Nissan Maxima 4-door sedan (Nissan #1), containing two male occupants, a driver and right front passenger, traveling at approximately 55 to 65 mph. After crossing a broken double-yellow centerline while attempting to pass slower traffic ahead, the Maxima was struck on the right by another vehicle also attempting to pass slower traffic. The Maxima's heading was forcefully redirected to the left, and it subsequently entered the left-hand shoulder. Differential friction between the inadequately packed, loose shoulder material and the asphalt covered road created an unfortunate situation for which the driver could not recover. The vehicle entered the shoulder and then re-entered the roadway several times until it ultimately struck a 12-inch diameter tree head-on located approximately 17 feet measured perpendicular from the road.

The second case concerns a 1987 Nissan Maxima 4-door sedan (Nissan #2), containing only a female driver, traveling in the #1 lane at approximately 45 mph. A vehicle in lane #2 suddenly veered left into lane #1, sideswiping the right side of the Nissan. The impact caused the Nissan driver to lose control, suddenly steer to the left and rise over the 5½ inch curb of the center median, and then strike a 14-inch diameter tree head-on. Due to the offset nature of the frontal impact with the tree, the Nissan subsequently yawed counter-clockwise, and then rolled over passenger side leading, coming to rest on its wheels approximately 48 feet beyond the tree.

Energy Analysis: Both collision vehicles were inspected and the residual collision damage was measured across the front bumper using a suitable reference coordinate system. An exemplar vehicle was inspected and its front bumper was similarly profiled. Scale drawings were used to quantify the residual collision damage. Vehicle crush stiffness characteristics (A and B values) were calculated from available government-sponsored barrier crash tests. The Campbell model, assuming a linear relationship between energy and crush, was used to calculate the vehicle's pre-impact speed.

Nissan #1, including the two occupants, weighed approximately 3570 lb. It sustained 20 inches of average residual crush. The corresponding crush energy was approximately 1.941×10^6 in-lb. After impact, Nissan #1 came to rest very close to the tree. That is, Nissan #1 had very little post-impact energy. Its pre-impact speed was determined to be approximately 37 mph.

By comparison, Nissan #2, including the driver, weighed approximately 3330 lb. It sustained 20.7 inches of average residual crush. The corresponding crush energy was approximately 1.804×10^6 in-lb. After impact, Nissan #2 rotated away from the tree, and the vehicle subsequently rolled over. After calculating the post-impact energy, the pre-impact speed was determined to be approximately 44 mph.

Restraint System Performance/Driver's Injuries: The vehicles involved are equipped with outboard front seat passive motorized shoulder belts and manual lap belts. Studies have shown that only approximately one-third of the driving population wear the available manual lap belt. The remainder of the drivers forget to buckle it, or are completely unaware that a manual lap belt exists, and more importantly, is vital to the enhancement of their occupant protection system.

The driver of Nissan #1 suffered closed head injuries and facial fractures. He suffers from extreme mental deficit. The driver of Nissan #2 suffered closed head injuries and significant facial fractures. She continues to suffer from facial disfigurement.

Structural Response to Tree Impact: The collision energy of Nissan #1 and #2 are within 7 percent, but the structural responses of these vehicles are quite different. The response of Nissan #1 to the tree impact is unremarkable, and exhibits many of the characteristics often observed in narrow object impacts, including knife-like penetration from the tree trunk, a semi-circular damage profile, and the wrapping of the left and right fenders around the intruding tree. However, the damage observed in Nissan #2 that resulted from the offset nature of the impact is exaggerated, such that there is considerably more induced damage, i.e. the pulling toward the tree of the structures far from the area of contact damage. More importantly is the vehicle's response to the tree penetration and the vehicle deformation that is outside the left frame rail.

In response to the tree impacting outside the left frame rail, the vehicle side structures becomes vital to the structural integrity of the vehicle. In Nissan #2, the left front door beam separated from the vehicle, because the welds at the front and rear of the beam failed. The left front door hinge post and cowl moved approximately 10 inches rearward. Without the stiffness afforded to the vehicle by the door beam, the occupant compartment was compromised. Intrusion rearward into the occupant compartment was considerable as the instrument panel and steering system were thrust toward the driver.

Conclusion: The structural response of a vehicle in a narrow object impact is dependent on the location of the point of contact. Near centerline impacts result in frequently observed deformation and wrap around. However, if the point of contact is eccentric to the vehicle centerline and misses stiff frontal structures, then the lateral vehicle structures become more important in sustaining the integrity of the occupant compartment.

In the case of Nissan #1, the vehicle deformation and restraint system performance were sidelined in the suit against the State for improper maintenance and compaction of the shoulder material which was at the heart of the differential friction phenomena and subsequent loss of control. In the case of Nissan #2, the structural response of the vehicle and inadequate occupant protection resulting from significant vehicle intrusion was the foremost theory of the analysis.

Narrow Object Impact, Structural Integrity, Tree Impact

C12 Causation and Consequences of Spring Failure in RCF 67 Buckles

Richard H. McSwain, PhD, PE, Mark B. Hood, BSME, PE, William D. Carden, MSME, PE, and Eric .L Van Iderstine, BSME, PE, McSwain Engineering, Inc., 3320 McLemore Drive, Pensacola, FL 32514*

After attending this presentation, attendees will understand the consequences to occupant safety of a material failure within the RCF 67 spring-loaded buckle.

This presentation will impact the forensic community and/or humanity by demonstrating how when investigating an accident with an unlatched seat belt restraint present, accident investigators should explore the internal condition of the buckle locking mechanism, and should look further into the possibility of accident-related restraint system release.

After attending this presentation, attendees will understand the consequences to occupant safety of a material failure within the RCF 67 spring-loaded buckle. This research specifically addresses instances where a latched seat belt buckle has released during a crash or rollover event, with no outward indication of damage of the restraint system. This paper will discuss the mechanism by which the internal spring can fail and will also explain why this failure can go undetected. This undetected failure can result in a release of the buckle during a crash or rollover event.

A failure analysis was performed on an occupant restraint system RCF 67 buckle that contained a fractured latch spring. The investigation consisted of a thorough metallurgical evaluation of the broken internal latch spring, analysis of the manufacturing processes used in the manufacture of the broken spring, and the correlation of processing variability to in-service performance of the internal spring. Metallurgical evaluation of the internal spring included optical microscopy, scanning electron microscopy, and chemical analysis. Interpretation of these results indicated that the spring had failed due to metal fatigue. Fatigue is the formation and growth of a crack or cracks that progressively grow in size due to repeated fluctuations of stress within a component. These fatigue cracks can ultimately lead to fracture of the components after a sufficient number of stress applications. The resistance of a component to fatigue damage is dependent on the design, material selection, and manufacture of that component. Through metallurgical analysis, it was determined that the fatigue initiated on the steel spring in an area of excessive phosphate coating. Phosphate coatings are known to produce pitting on the surface of certain steels. This pitting results in a stress concentration in the metal; the stress concentration due to the phosphate coating process reduces the fatigue resistance of the spring.

Testing of RCF 67 buckles with normal, un-failed springs, and RCF 67 buckles with fractured springs, was performed to compare the acceleration impulse required to cause an inertial buckle release. The testing was performed on a guided-rod drop fixture with sliding carriage. RCF 67 buckles were clamped horizontally to the drop fixture carriage and a weight was suspended from the latch plate webbing to preload the belt buckle. The carriage of the drop fixture was instrumented with an accelerometer and the accelerometer was connected to a data acquisition system to record the time history acceleration of the buckles. The carriage was dropped from varying heights onto elastomeric pads, and the pads were used to shape the resulting acceleration pulses. The testing revealed that buckles with fractured springs required approximately 75% less acceleration to cause an inertial release when compared to buckles with normal, un-failed springs.

During the failure investigation, it was determined that buckles with fractured springs can not only give an audible latch, but can feel secure to vehicle occupants. Therefore, damage to the locking mechanism can be imperceptible to vehicle occupants.

When investigating an accident with an unlatched seat belt restraint present, accident investigators should explore the internal condition of the buckle locking mechanism, and should look further into the possibility of accident-related restraint system release.

Buckle, Fatigue, Spring

C13 RV Shower Seat Failure and Resulting Injuries Due to Incomplete Assembly Instructions

Donn N. Peterson, MSME, PE, Peterson Engineering, Inc., PO Box 664, Brainerd, MN 56401-0664*

After attending this presentation, attendees will learn of the need for adequate instructions by parts suppliers. They will also learn of the role of hidden and non-standard features in a sub-component of a consumer product

This presentation will impact the forensic community and/or humanity by demonstrating the need for adequate instructions with sub-assemblies and components and the consequences for not providing them.

Background: Mr. X ordered an RV (recreational vehicle) from a manufacturer of luxury motor homes. He initially used it for recreational purposes only, and he later used it for his living quarters. About 3½ years after his purchase, he was showering and in order to wash his feet he sat on the fold down seat which was mounted on the shower wall. The fiberglass seat tabs failed about the hinge pin line and caused him and the seat to fall approximately 18 inches to the shower floor resulting in low back injuries. An investigator found one of the two stainless steel hinge pins lying on the shower floor along with the seat and its broken tabs. He removed the wall mounting bracket and seat components for evidence preservation purposes. The removed parts were replaced during repair of the RV before it was returned to service.

Plaintiff's attorney made the removed parts available to his retained experts, a mechanical engineer, and a metallurgical engineer. His mechanical engineer inspected the repaired RV before it was sold. Plaintiff's experts both opined that the hinge pin had dislodged from the mounting bracket and caused seat tabs to fail. They further opined that the hinge pin loosened and dislodged due to improper assembly during the manufacture of the RV. They specifically stated that they were not rendering any opinions regarding the design and manufacture of the seat or its mounting bracket. Plaintiff's attorney filed suit against the American RV manufacturer, without naming the foreign seat manufacturer.

The RV manufacturer's attorney arranged for the author to be retained to perform forensic engineering services in evaluating the claim. The removed parts were inspected and a used exemplar seat was obtained. Analytical stress analysis were performed to evaluate potential for failure of the seat tab(s). Results indicated that the seat tabs are not expected to fail during normal or even mildly abusive usage if the hinge pins are securely fastened to the mounting bracket. Results indicated that if one hinge pin is completely removed, the additional torsion stresses at the remaining hinge pin predict failure in that seat tab, but not in the seat tab from which the hinge pin is removed.

The mounting bracket has threaded receptacles into which the threaded ends of the hinge pins are engaged. These receptacles are largely obscured within the bracket interior. The interior ends of these receptacles have plastic inserts beyond the metal threads which are fully obscured. If the hinge pin threads fully engage the metal threads and extend sufficiently far into the plastic inserts, then the plastic inserts provide a locking function to prevent the pin threads from loosening during normal usage. If the hinge pin threads do not extend sufficiently far into the plastic inserts, then there is no locking function and the pin threads can loosen during normal usage.

The seat manufacturer's instructions make no mention of the plastic inserts or their locking features. They instruct the user to "fully tighten pins with a tubular key." A tubular key is not a standard tool and is not provided with the product.

Products, Component, Instructions

C14 Falsifying a Hypothesis: Real Science in the Dirt

Andrew J. Friedman, BA, BS, OGW Research, Inc., 4253 Woodland Park Avenue North, Seattle, WA 98103-7433*

After attending this presentation, attendees will have been given a specific example in of the use of applying convergent data to answering complex environmental and litigation questions.

This presentation will impact the forensic community and/or humanity by driving home with a concrete example the all too often overlooked fact that the actual job of science is the falsification of hypotheses.

In the summer of 2005 the authors were confronted with a most interesting problem, the proving of a negative. This is an unusual problem, since if the thing to be examined simply isn't there, how do you examine it for its properties?

Our client, a remediation company, had contracted to remediate a piece of land prior to transfer of title, that was believed to have been mildly contaminated with diesel-range petroleum hydrocarbons during previous usage as well as with carcinogenic polynuclear aromatic hydrocarbons (cPAH) originating from old railroad activities adjacent to the property. With this in mind, the remediation contractor had stripped away the surface soils and begun a bio-remediation plan for the sub lying soils where the lighter hydrocarbons had entered by gravity. All proceeded fairly smoothly until higher levels of hydrocarbons were discovered at greater depth, culminating in the discovery of an abandoned fuel tank and significant levels of leaked fuel. The remediation team proceeded with the bioremediation plan, expanding the scope, until what had been estimated to be a 4,000 cubic yard remediation had expanded in scope to encompass closer to 15,000 cubic yards of material. The local representatives of the State regulatory authority stepped in at this time, expressing their opinion that the entire bioremediation activity had been a fraud, that the remediator had merely tilled the soils, mixing clean soils with contaminated soil until levels below the threshold for action were attained. Under this scenario, the entire mass of disturbed soil, having been subject to dilution had to be considered as contaminated as the original problem soils and disposed of as hazardous material (Dilution is no Answer to Pollution!). A new contractor was brought in and a plan to remediate the soils based on the presence of the remaining cPAH developed. The original contractor, complaining that he had been improperly removed, developed an alternative plan and requested that his plan be considered. The State regulators, still insisting on their original scenario, required that he prove that his entire project was not a dilution, but had, in fact, resulted in bio-remediation before they would even discuss the remaining issues with him.

We were hired to examine samples from the site and all existing data from the course of the remediation to determine whether the losses of hydrocarbons observed were more likely to have been from dilution of the soil or biodegradation of the hydrocarbons present. The authors were unable to compare the hydrocarbons present in the fuels before and after remediation because the original analyses of the fuels were of a type that gives very little composition data (total diesel-range petroleum hydrocarbons, TPHd) and the final post-treatment concentrations being below the detection limits used by the laboratory precluded even examination of the distillation pattern of the material present for the grossest characterization.

Physical and chemical (PAH distribution) examinations of the contaminated soils indicated that the cPAH remaining in the soils were primarily due to the presence of particles of asphalt, with smaller amounts of coal and ash rather than from residual fuels. With this in mind, it was felt there was finally had something to examine. CPAH associated with these activities had been found in the preliminary investigations, and the materials involved are not expected to be significantly affected by bio-remediation techniques without extraordinary measures. Comparisons of the levels of cPAH in the more contaminated soils before and after remediation were made. These indicated that even if the highest levels of these compounds had remained in the soil after the surface stripping, then dilutions of the order of 2-10 times might be expected (not unusual in land farming operations), while the loss of fuel hydrocarbons seen would require dilutions more on the order of 50 to 100 times. Since the soils had been treated without bias of what was present, it was unlikely that the soils containing the asphaltic particles were any less diluted than those containing only fuel hydrocarbons. Armed with these analyses the original remediator was able to prove to the regulators that significant dilution had not occurred, and that bio-remediation did account for the bulk of the diminution of the contaminating hydrocarbons and get them to examine his further proposals.

Soil Contamination, Convergence of Data, Dilution Issues

C15 A Reality Check on EPA Reference Values and Model Equations in the Soil Screening Level Guidelines

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The goal of this presentation is to present procedures for the review of reference values, and issues related to the use of non-peer reviewed models will be discussed.

This presentation will impact the forensic community and/or humanity by demonstrating the use of some methods to review and identify potential errors in reference data, and will document a serious problem with a model equation developed by the EPA and incorporated without significant scientific review into most State's regulatory guidance.

Environmental investigations frequently require the development of conceptual models to fill in the data gaps and provide a method for assessing what has happened and will happen at a site. These models are usually based on procedures promulgated by the EPA that have been incorporated in State and local regulations. Unfortunately, many of the EPA model equations and reference values have not been given any peer review for scientific legitimacy, nor have they been validated by any sort of comprehensive field investigation. When confronted with shortcomings in the performance of the models, the regulatory response is generally to presume that more site-specific information is needed, and/or to opine that the model is "conservative" and therefore satisfies their requirement to be protective. Rarely is an investigator prompted to develop a more accurate model using scientific procedures.

The EPA Soil Screening Level Guidelines (SSL) have been incorporated almost wholly into State and local environmental regulations without any scientific review. One of the equations in the SSL is supposed to model the concentration at which soil is saturated with an organic contaminant, the C_{sat} calculation. Dimensional analysis shows that this equation does not model the soil saturation concentration. The erroneous equation was apparently created by a desire for an expedient solution to the problem. The model is used in many State's regulations and this apparently is the first scientific review to identify the problems in the model.

Recently, it was shown that reference values, such as those provided in the SSL, may be in error by several orders of magnitude (USGS). A simple review of the reference values in the SSL using routine sorting and calculation functions in a spreadsheet program showed several values are questionable. A review of the scientific literature and web-based information sources showed that more reasonable values exist, and the corresponding values in the SSL may have been transcribed inaccurately or may not have been checked for accuracy and reasonableness.

Given that most State and local environmental regulations are based almost entirely on procedures handed down from the EPA, most of which have not received any rigorous scrutiny, it is reasonable to assume that many of these routines are riddled with serious errors and marginal scientific merit. It is recommended that environmental investigators involved in developing a conceptual site model should carefully review the equations and reference values provided for accuracy and reasonableness. Excuses for shortcomings in the regulatory approaches should not be tolerated and more accurate models based upon legitimate science should be put forward by site investigators.

Soil Screening Levels, Reference Values, Model Equations

C16 Uncertainty in Plume Delineation

Willem A. Schreuder, PhD, Principia Mathematica, 575 Union Boulevard, Suite 320, Lakewood, CO 80228*

After attending this presentation, attendees will have an increased understanding of the uncertainty associated with plume delineation, error bands associated with concentration contours and volume calculations.

This presentation will impact the forensic community and/or humanity by increasing awareness of the limits of computer generated contours.

Delineation of plumes from observations is a widespread activity in the analysis of contamination. The shape and extent of the plume is almost always presented as a single representation. This paper discusses the uncertainty involved in the plume depiction. In particular, the paper investigates the uncertainty resulting from data uncertainty and the extremes of the plume.

Depiction of a two or three dimensional plume is typically based on an interpretation of a set of point data. This process involves the interpolation and extrapolation of the point data. Some of the interpolation methods such as kriging contain error estimates that can be used to bound the interpolated values. Using these error estimates the uncertainty in the plume predictions can be evaluated.

The point data from which the plume is derived also has an associated uncertainty, but this is rarely considered. The paper describes a technique by which a rigorous uncertainty analysis can be used to evaluate the uncertainty resulting from the data can be evaluated.

The paper demonstrates the relative contributions of the two types of uncertainty as applied to a two dimensional plume.

Contamination, Extent, Uncertainty

C17 Use of Cytochrome P-450 1A Response to Extracts from Semi-Permeable Membrane Devices to Identify Sources of Organic Pollutants

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After attending this presentation, attendees will understand a new and powerful method of linking field evidence of biological impacts to the causative contaminant source in studies conducted in support of environmental litigation.

This presentation will impact the forensic community and/or humanity by demonstrating increasing the appreciation of the power derived from combining molecular biological biomarker metrics (e.g. cytochrome P450 1A induction) with methods for passively concentrating environmental contaminants to narrow the field of plausible suspect sources in environmental forensic cases.

Assessing complex mixture toxicity by summing their concentrations may not be sufficiently realistic to evaluate or predict the consequences of exposure. An effective alternative involves the modification of a well-documented form of mimetic chemistry, the semi-permeable membrane device (SPMD), and the exposure of test animals to its contents. This method allows the evaluation of the effects of those bioavailable compounds present, including those whose analysis is

difficult with their breakdown products and metabolites, as encountered in situ. This approach facilitates an evaluation of toxicity for each sample and site as a unit. In situations where chronic adverse effects from organic contaminants on aquatic biota are evident but the source is not obvious, this approach may be used to help isolate the proximate cause. This approach was applied to the Prince William Sound, Alaska, the site of the 1989 Exxon Valdez oil spill, to evaluate which of several prospective pollution sources best account for evidence of chronically depressed populations of sea otters and some sea ducks there.

SPMDs for the standard 28-day deployment period were deployed, recovered, and concentrated accumulated organic contaminants, and injected aliquots of extracts containing the contaminants in juvenile rainbow trout (*Oncorhynchus mykiss*). The juvenile trout were sacrificed after 2 or 7 days, the livers excised and examined with the ethoxyresorufin-*o*-deethylase (EROD) bioassay. The results demonstrate that even after fifteen years, there is enough bioavailable oil in formerly oiled intertidal habitats of Prince William Sound to elicit a marked induction of CYP1A. The induction potential from oiled sites are comparable to those from a boat harbor (hot control), and are significantly elevated above environmental controls from sites that were not oiled. These results indicate that oil bioavailability is real, and can be evaluated with this technique.

Measurements of CYP1A induction were used to compare the potency of lingering oil from the 1989 Exxon Valdez oil spill (EVOS) with pollutants from alternative sources. Arrays of SPMD were deployed at intertidal sites where EVOS oil remains, at other intertidal sites impacted by present or historical human activity, at salmon streams to assess pollutants imported to PWS by migrating salmon, at Constantine Harbor where a suite of natural petrogenic hydrocarbons is present in intertidal sediments, and at randomly-selected sites to assess inputs from atmospheric transport or from ambient seawater. CYP1A induction was measured by the EROD assay applied to homogenized rainbow trout livers two days following injection. SPMD extracts were also analyzed for polycyclic aromatic hydrocarbons (PAH) and for a suite of persistent organic pollutants (POP) including chlorinated pesticides and PCBs. The magnitude of CYP1A induction caused by SPMD extracts from the EVOS sites ranged from 28 – 72 pmol/mg/min, much greater than elsewhere (1.5 – 6.5 pmol/mg/min; median 2.5). The CYP1A induction from the oiled sites was significantly ($P < 0.01$) related to total PAH concentrations of the extracts, and these all fingerprinted to EVO.

Of the nine human activity sites (hatcheries, old mine sites), only one current use site registered significant loads of PAH and stimulated a CYP1A response. At 45 un-impacted sites (salmon streams, non-oiled areas, random marine sites), background concentrations of PAH and POP stimulated a weak (< 6.5 pmol/mg/min) to negligible CYP1A response. These results indicate that POPs are negligible as CYP1A induction agents in PWS, as are PAH associated with historical human use sites (except at Sawmill Bay), whereas oil from the EVOS remains a potent CYP1A induction agent.

The EROD assay of exposed trout livers proved to be a very sensitive response to the accumulated contaminants. Absent readily identifiable local pollution sources, most of Prince William Sound was so clean that trace levels of EROD-inducing agents initially present in the SPMDs as received from the manufacturer were significantly lowered through losses to the environment at the end of the 28-day exposure period. Hence, in Prince William Sound, this method provided a very sensitive method for evaluating relative contributions from a manifold of pollution sources to the adverse biological effects observed in sea otters and ducks.

Exxon Valdez Oil Spill, Semi-Permeable Membrane Device, Cytochrome P450 1A

C18 Pacific Salmon and the Endangered Species Act: Using STR DNA Analyses to Determine the Population of Origin of Fish Carcasses

*Piper L. Schwenke, B.S.**, Paul Moran, PhD, Anna E. Elz, MS, and Linda K. Park, PhD, National Marine Fisheries Service, NWFSC, 2725 Montlake Boulevard East, Seattle, WA 98112

After attending this presentation, attendees will understand how forensic DNA analyses can be applied to wildlife and environmental management.

This presentation will impact the forensic community and/or humanity by demonstrating the wide range of capabilities DNA and STR analyses.

Pacific salmon and steelhead are an anadromous (fresh and marine water) fish with a complex life-cycle that spans a variety of fresh and saltwater habitats. Salmon are hatched in freshwater streams and rivers, migrate to coastal estuaries, and disperse into ocean waters to grow. Once mature they return through the estuaries and migrate upriver to their natal streams to reproduce. NOAA Fisheries Service received a petition in 1991 to list Pacific Northwest salmon populations under the Endangered Species Act (ESA). The ESA allows listing of “distinct population segments” of vertebrates and for salmon the distinction was established as “evolutionarily significant unit,” or ESU. NOAA Fisheries Service conducted a biological review of all anadromous salmon species on the West Coast and identified 52 ESUs, and evaluated whether they were at risk of extinction and should be considered for listing as threatened or endangered under the ESA. Currently there are 26 Sockeye, Chinook, Coho, Chum, and Steelhead ESUs listed as endangered or threatened “species” under the ESA. NOAA Office of Law Enforcement (NOAA OLE) is mandated to enforce the Endangered Species Act (ESA). Endangered Species Act violation investigations often require forensic molecular genetic expertise to positively identify carcasses to ESU of origin. Species identification of adult salmon is easily determined using diagnostic morphological and genetic markers. Although in some cases the question is: Which ESU did this fish carcass come from? The small amount of individual straying of individuals or gene flow between populations precludes the use of unique genetic characters to identifying ESUs; nonetheless, the ESU of origin can be ascertained by using population genetic analyses because of the extensive reproductive isolation between ESUs and populations within a species. In order to identify individuals to an ESU, a substantial amount of genetic information must be collected across the geographic range of that species. This genetic baseline is then used to evaluate the likelihood that an “unknown” fish carcass is from a specific ESU. Many investigations of illegal kills of endangered or threatened salmon involve wild Chinook salmon. The evidence is usually fillets or whole fish from a defendant’s freezer or cooler. NOAA OLE requires forensic genetic analyses to verify the illegally caught fish were actually from an endangered or threatened ESU. Because there are no diagnostic genetic markers to identify the ESU of origin, baseline genetic allele frequency data across all Chinook salmon populations to identify ESU of origin are relied on.

The genetic baseline from Chinook salmon contains data from 15,975 individuals from 109 populations across the geographic range of the species in North America. This includes but is not limited to the 17 Chinook salmon ESUs, of which nine are endangered or threatened to be extinct. Thirteen STR or microsatellite markers were used to collect the allele frequency data across all Chinook populations in the genetic baseline. The baseline allele frequency data essentially provides the empirical data signature, which will be used to identify the ESU of origin for an unknown fish carcass. The author will present data from forensic validation studies of the Chinook microsatellite (STR) baseline and provide examples of how to determine the ESU of origin using

likelihood statistics to provide confidence values for the ESU assignment. Although current capabilities are for Chinook salmon ESU identification, genetic baselines for Chum salmon, Coho salmon, and Steelhead are being developed. Forensic casework involves identifying the species first and then determining the multilocus genotype of the Chinook salmon individual(s) for population genetic analyses. Determination of ESU involves a statistical analysis that first calculates the probability of assignment for an individual genetic profile to each population in the Chinook genetic baseline. These probabilities are used to calculate overall likelihoods of assignment to the ESU in question. The ESU assignment statistics utilize a partial Bayesian statistical method to determine the probability of assignment to population for each genetic profile at 13 microsatellite (STR) markers. This method employs a Monte Carlo simulation to generate a distribution of likelihoods from the simulated genetic profiles for each potential source population in the baseline. Based on these empirical distributions, the probability of the genetic profile for an unknown individual coming from each population is evaluated using the exclusion significance test described by Cornuet et al. (1999). The overall likelihood for a genetic profile to be assigned to an ESU is calculated by summing the probability of assignments for all populations in the ESU in question divided by the sum of all probability of assignments for all populations in the genetic baseline. This creates a likelihood ratio of the ESU in question compared to all populations in the Chinook genetic baseline.

Endangered Species ACT, Pacific Salmon, DNA

C19 Quality Assurance Elements for Environmental Analyses

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After attending this presentation, attendees will gain insight on how the results of the quality assurance for a study may determine how the analytical data can justifiably be used.

This presentation will impact the forensic community and/or humanity by demonstrating how the incorporation of appropriate quality assurance can ensure that the goals of an investigation can be met.

Attention to quality assurance for environmental analyses has grown over the last few decades due to the increasing necessity to document the extent to which reported data are suitable for their intended use. Analytical techniques have evolved to meet the demand for better data quality and documentation. However, quality assurance requirements and quality control measurements can vary widely depending on the specific project and the level of planning prior to the analyses. It is beneficial for data users to be familiar with the quality control measurements that are possible and the performance attainable for their study. This allows the data users to incorporate, prior to the production of the data, assurance that a desired level of quality can be demonstrated and maintained, and that the data generated will include the necessary documentation showing the data to be of known and acceptable quality.

The Environmental Conservation Division of the NOAA Northwest Fisheries Science Center analyzes marine biota and sediment to measure concentrations of polynuclear aromatic hydrocarbons and persistent organic pollutants as low as 0.2 ng/g wet weight, while maintaining documented, comprehensive quality assurance for accuracy, precision, representativeness, comparability and completeness. This is achieved by implementing internal policies designed to ensure that stringent, internal data quality objectives are met. These policies and quality assurance objectives will be presented, including specific elements of project planning and the laboratory’s particular quality control measurements, their frequency, acceptance criteria and

documentation. Innovative analytical techniques have been designed and incorporated in order to meet the laboratory's quality objectives and improve quality where possible. These include implementing procedures for increasing the stability of analytical instruments and determining the optimal method of instrument calibration. In addition, data quality and comparability have been shown to be affected by the choice and application of calibration standards and internal standards, and by the determination and use of quantitation limits. Related examples of situations that influence data quality or comparability and the corresponding documentation that data users may need will be discussed to illustrate how these factors may control how data use can be justified. The quality assurance concepts that will be presented can be extended to many types of analyses to help provide confidence that the goals of the investigation can be met.

Quality Assurance, Quality Control Measurements, Documentation

C20 NIST Standard Reference Materials (SRMs) for Water Measurements and Analysis

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After attending this presentation, attendees will understand the availability and use of certified NIST Standard Reference Materials (SRMs) related to water measurements and analysis and criteria for data validation.

This presentation will impact the forensic community and/or humanity by discussing a range of Standard Reference Materials (SRMs) for water measurements and analysis of interest to the forensic community. The discussion will encompass precision, accuracy, and traceability considerations to be taken into account to validate data.

This paper discusses the application of certified NIST Standard Reference Materials (SRMs) in instrument calibrations for the measurement, identification, and assessment of a wide range of toxic substances in water, and for the comparison and evaluation of water samples. In these measurements, SRMs provide the benchmarks to assess the levels of precision, accuracy, and traceability required to validate the measurements and data.

NIST supports accurate and compatible measurements by providing over 1300 Certified SRMs with well-characterized composition and/or properties. These SRMs are used to perform instrument calibrations in situ as part of overall quality assurance programs, to verify the accuracy of specific measurements and to support the development and standardization of new measurement methods. NIST SRMs are currently available for use in areas such as industrial materials production and analysis, environmental analysis, food and agriculture, radioactivity, health measurements and basic measurements in science and metrology. Each SRM is supplied with a Certificate of Analysis. Along with standards organizations methods and procedures, such as those promulgated by ASTM and ANSI, NIST has published many articles and practice guides that describe the development, analysis, and use of SRMs. NIST SRMs provide the benchmarks of precision, accuracy, and traceability, which validate measurements and data.

The measurement of physical, optical, and chemical properties of samples is often employed to identify a type of material or substance. Measurements and analysis of water samples can be used identify chemicals or materials, and to track the original producer, the date or period of manufacture and the intended use or application for the material or product. For example, chemical or property measurements and/or the evaluation of samples can establish a link in the chain from producer, distributor, vendor, end-use, or application, down to a specific geographical area or sample origin.

In the measurement of properties, chemical composition, or characteristics of samples, accuracy, and uncertainty terms and traceability statements are of paramount importance in forensic investigations for the validation of data. These concepts must be used correctly to avoid possible confusion and inadmissibility of evidence. SRMs and the associated Certificate of Analysis state the intended purpose and application of a particular SRM, its certified property value(s) with associated uncertainty(ies), and present technical information deemed necessary for its proper use. The uncertainty attached to a certified value is especially important as it represents a quantity that characterizes the range of values within which the true value is asserted to lie within a stated level of confidence. A NIST SRM certificate bears the logo of the U.S. Department of Commerce, the name of NIST as certifying body, and the name and title of the NIST officer authorized to accept responsibility for its contents. In addition to the certified values, the SRM certificate may contain references and/or other pertinent information and data. SRMs certified values with their associated uncertainties, in applicable situations insure the integrity and the validation of forensic measurements and data. NIST certified values are obtained by one or more of the following measurement modes: 1) A definitive (or primary) method using specialized instrumentation capable of high accuracy and precision and whose errors have been thoroughly investigated and corrected; or, 2) Two or more independent methods at NIST using commercial instrumentation that is calibration based and with differing sources of systematic errors; or, 3) Inter-laboratory data from selected laboratories using multiple methods and SRMs as controls. However, the sources of error with the latter mode will generally result in uncertainties greater than those for the other two modes.

There are a number of measurement methodologies related to water analysis. Some employ basic chemistry procedures while others use very sophisticated techniques, which make use of atomic and radiation physics principles, and nuclear interactions that require complex and expensive apparatus. Fortunately, a number of SRMs of interest to the "water community" have been established for standardized laboratory evaluations. These SRMs and associated methods or standard procedures are available for equipment calibrations.

This paper will discuss and illustrate the use of a number of SRMs for water measurements and analysis of interest to the forensic community. The discussion will encompass measurement practices, methods, standards, and precision and accuracy considerations to be taken into account for the measurement methodologies employed. This paper will also provide insights on the future needs for SRMs for forensic measurements and characterization.

Standards, Water, Calibrations

C21 Should Environmental Forensics Just Be About the Liability for the Past or Can It Help Us Avoid Liability in the Future?

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After attending this presentation, attendees will leave this presentation with a better understanding of the issues facing those addressing "long term" containment of hazardous materials and wastes, some of the approaches that are available and knowledge of the case studies used to develop a framework for the authors' analysis.

This research goes to the heart of what forensic discussions of long-term contaminant isolation and this presentation will impact the forensic community and/or humanity by demonstrating the need to address in the future and will aid forensic scientists, designers of such facilities, monitors of such facilities, and/or litigants concerning such facilities.

The field of environmental forensics emerged from litigation involving past waste management practices that are now understood not to be protective of human health and the environment. In the wake of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA or Superfund), the need arose to use the best science available to determine the sources of past hazardous chemical and radionuclide releases and the times when those releases occurred. Current environmental forensics practitioners have at their disposal a variety of source identification and release dating tools including chemical fingerprinting, “reverse” modeling, times of commercial availability, and isotopic identification and dating techniques.

For the past several years, the authors have been engaged in research on another component that is emerging as a very important piece as well, viz., the long-term management of so-called legacy hazardous and nuclear waste sites. All across the U.S. and abroad current waste site remediation approaches are not able to leave the property suitable for unrestricted use due to technological and economic limitations. Residual hazards will be left in place hopefully isolated by the implementation of engineered barriers and institutional controls, the purpose of which is to preclude intrusion into or migration from the waste materials being isolated. The processes by which the decisions about how these sites will be remediated and monitored are subject to considerable political, regulatory and potentially litigious discussion currently and this is expected to continue into the future. Given the long times for which the contaminants being isolated will remain hazardous, these “contaminant isolation systems” will need to perform effectively for 100s perhaps 1000s of years.

Case studies of several sites have been used to identify the types of engineering and institutional controls currently in use. The information from the case studies has been used to define an analytical framework and “precursors to failure” can be identified using fault or event tree analysis. Institutional responsibilities can then be focused on monitoring and maintenance of both the engineered barriers and the institutional controls with emphasis on selected precursors to system failure.

The presentation will provide background information on the need for sustainable long-term environmental protection of legacy hazardous and radioactive waste sites, the results of the case studies and fault tree analyses to date, observations, and conclusions, and recommendations for further research.

Environmental Forensics, Engineered Barriers, Institutional Controls

C22 Technical Issues in the Criminal Case of *United States of America v. W.R. Grace, et al.*

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After attending this presentation, attendees will learn information about dealing with complex technical forensic issues involved in environmental criminal cases.

This presentation will impact the forensic community and/or humanity by updating the current status of the Libby, MT - W.R. Grace federal criminal litigation through a discussion of the technical forensic issues.

In February 2005, W.R. Grace & Co. and seven of its top executives, both current and former, were charged by the U.S. Justice Department with knowingly endangering its workers and residents of Libby, Montana. The criminal indictment charged that their vermiculite mine, which closed in 1990, released dangerous, cancer-causing asbestos into the air for decades and that WR Grace Company officials knowingly concealed information about the deadly health effects. Some of the technical issues involved the testing of vermiculite containing as

a contaminant, amounts of tremolite and similar amphibole minerals, and the microscopical methods that are used to measure asbestos in air, soil, and dust. As part of the case, the Government asked for a Daubert-type Hearing on the admissibility of the methodology used by Defendant Grace’s analytical expert. The Government with the help of their expert witnesses contended that the Defense expert had incorrectly alleged that the Government’s choice of an analytical method for asbestos air analysis was wrong. The Defense expert contended that the government should have used a Draft method produced by Yamate in 1984 instead of the method published by the International Standards Organization in 1995 (ISO 10312). The Government data showed how the Defense expert had added on another procedure to the Yamate method that they considered not reliable and not accepted by the scientific analytical community. The Defense presented contrary information. There was no testimony from the Defense expert. The Government’s motion was denied and the expert allowed to testify at trial. This presentation will discuss the difficulties encountered by a forensic scientist in handling technical information in an environmental criminal case.

Vermiculite, Asbestos, Libby, Montana

C23 Converging Evidence: A Bayesian Example

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After attending this presentation, attendees will learn how mutually exclusive hypotheses and Bayesian inference are practical tools that can help sort and evaluate analytical information in complex cases. This presentation will incorporate examples from environmental casework.

This presentation will impact the forensic community and/or humanity by demonstrating the use of mutually exclusive hypotheses and Bayesian inference can assist forensic practitioners in meeting the interests of the courts in presenting defensible and falsifiable analyses in environmental and other cases. It should aid practitioners in performing focused work that can address the issues of interest in a scientifically reliable way.

Preliminary results for a contaminated site performed to determine regulatory compliance do not always answer questions about who is responsible and what they should do about it. As a case moves from regulatory compliance to forensic investigation to litigation to remediation, and the first rounds of testing do not yield a simple and obvious answer, it is useful to have a few tools to sort through the information and to evaluate what the results mean. This is especially important when things are complicated and multiple hypotheses can be offered in explanation. A clean experiment means that the scientist or engineer knows what questions have and have not been answered. It is critical to focus the analytical questions so that any additional work would have an impact on the case questions, and to eliminate untenable hypotheses so the remaining ones can be evaluated. The focus of this paper is on hypothesis formation after some of the results are in, and the use of formal mutually exclusive hypotheses and Bayesian inference as a means for narrowing down hypotheses, focusing any testing that should still be done, and weighing the final hypotheses.

For mutually exclusive hypotheses A and B, if A is true, B is not true, and if B is true, A is not true. A formal hypothesis suitable for comparing with its antithesis should be clean and simple, and any conditionals (the “true ifs”) placed into separate hypotheses so a comparison of hypotheses is easy to interpret. For example, if lead is found in soil samples from a site, and white paint chips and metal bearings are also found in the soil, the latter are both possible sources of lead, and there may be unknown contributors as well. One could construct the following hypotheses: 1a) the lead in the soil is from white

paint chips and metal bearings only; or 1b) the lead in the soil is from white paint chips, metal bearings, and an unknown source. "A" would be true if no lead is found in the extracts. It may also be true if lead from either or both sources has leached into the soil. "B" would be true if lead is found in the extracts but in a form not explained by leaching of the paint or metal bearings. Lead in the extracts may also be from both leaching and another source. This does not provide a clean answer, so additional hypotheses may be needed: 2a) The lead in the soil sample extracts is that leached from white paint chips and metal bearings only; 2b) The lead in the soil sample extracts is from another source only; or 2c) the lead in the soil sample extracts is from both paint-and bearing-leached lead and from another source. These hypotheses can probably be resolved through additional testing, and the construction of the problem is now clean enough to allow focused testing. It may be that existing data can resolve them; the comparison of hypotheses allows for a quick determination of the needed data.

It may not be possible to test this further. When additional testing is not possible, the existing information must be evaluated and weighed. In comparing Hypotheses 2b and 2c, for example, the scientist or engineer should weigh the two possibilities to determine whether Hypothesis 2C is not only possible, but whether it is reasonably likely. It is also important to remember that something may be true even if is unlikely. That is why formal statistical evaluation or other evaluations of likelihood should not be attempted until testing to distinguish hypotheses has been performed. Other tools to use in evaluating data after additional testing is not possible include asking: "if it is not what I think it is, what else might it be?" This can produce additional hypotheses to evaluate and can help re-focus on the actual data. Another tool is to find the best fit with the evidence via evaluation of the convergence of data. A specific test result and analytical conclusion may have several possible explanations, but when all the test results and conclusions are considered, each of them may include one or two of the many possible data point explanations. This is where the data converges. The explanation where all the data converges is usually the best explanation, and an explanation where some of the data converges and none contradicts it is another possible explanation. The latter should be included in a reporting of results, as it may be true.

After the mutually exclusive hypotheses have been constructed, and any additional testing performed, the remaining hypotheses should be evaluated and weighed. A useful statistical tool for doing so is Bayesian inference. Bayes's Rule expresses the probability that a certain event has occurred given a specific condition or conditions of measurement. It does this by relating the probability of the event given the evidence, to the probability of the evidence given the event. This is a way to measure the impact of the evidence on the overall probability. For example, it can be used to derive the probability that lead contamination is attributable to the peeling white paint of oil storage company tanks at the site being investigated, and metal bearings from the railroad previously on the site, given the condition that lead was found in the soil in the corresponding white paint chips, the metal bearings and the extracts. As a model, it is broadly applicable to evaluating scientific endeavors, and is of particular interest in comparing a hypothesis with an alternative hypothesis in light of a particular analytical result(s). In the aforementioned example, an alternative hypothesis might be that despite the presence of lead in the paint chips and metal bearings, the lead in the soil extracts is actually from another source.

A particularly useful form of Bayes's Rule for forensic scientists and engineers is to write the rule as a statement of odds rather than as a statement of probability, so that any probability is compared with its antithesis. This is what an odds statement entails. Thus, the odds of the event occurring given specific evidence are related to the overall odds of the event via a ratio. This ratio is called the Likelihood Ratio, i.e., a ratio of the probability of the evidence given the event, versus the probability of its being there even if something else happened instead. Thus, when two mutually exclusive hypotheses are being compared, the probability of one is being divided by the probability of other.

In mathematical language: Where J is the event (i.e., the scenario) and I is the condition (i.e., the evidence or result), Bayes's Rule — written in terms of odds rather than probability — is: $O(J|I) = O(J) [P(I|J)] / [P(I|not-J)]$, where $O(J|I)$ is the odds of event J occurring given the condition I; $O(J)$ is the odds of event J occurring; $P(I|J)$ is the probability of condition I being present if event J occurs; and $P(I|not-J)$ is the probability of condition I being present if event J does not occur.

Even if a statistical evaluation cannot be performed for a lack of hard numbers, which may be difficult to come by when an unknown source is being considered, the reasoning involved in statistical evaluation can be applied, especially when Bayesian inference is used. It is more interesting to estimate some probabilities based upon data from other investigations to see how a comparison of the estimated probabilities would affect the overall questions being addressed. In this paper, the authors will present a Bayesian analysis of evidence in an environmental investigation using estimated probabilities of the data.

In summary, mutually exclusive hypotheses are a powerful tool in focusing analytical questions and narrowing down hypotheses in complex investigations once some of the analytical results have already come in. Bayesian statistical analysis is useful in evaluating and weighing the hypotheses that remain after testing has been completed. These tools are accessible to the forensic scientist and the forensic engineer, even those who do not have formal training in statistics, and are useful in a broad range of investigations.

Environmental Forensics, Forensic Science, Bayesian Inference

C24 Attention Environmental Forensics Practitioners: Important Information Is Out There - and It's Free!

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After attending this presentation, attendees will learn about a free source of peer-reviewed information relevant to their work and the way to access the information.

Practitioners of environmental forensics will be able to access critical historical and current information through a peer-reviewed information source. This information source contains material that is often very hard to find. This presentation will impact the forensic community and/or humanity by demonstrating how associated databases can facilitate communication with non-practitioners and the lay public will be discussed as well.

There is an amazing amount of information available on-line. However, there is a source of information, often quite relevant to environmental forensic applications, which is not known to many in the field. Specifically, Specialized Information Systems (SIS), the National Library of Medicine (NLM), National Institutes of Health (NIH) has, by order of Congress several years ago, offers a broad menu of data bases whose focus is *not* just health effects.

Of particular interest is the Hazardous Substances Data Bank (HSDB). This is part of the TOXNET set of databases. The HSDB contains records on over 4700 chemicals and drugs as well as several radioactive compounds. The list of HSDB chemicals is continuously increased as additional chemicals become "of concern." The contents of all the records are peer reviewed by ongoing panels of experts (scientists, physicians, engineers, toxicologists) prior to the records being opened to the public. The records are continuously reviewed and updated.

The Peer Review Panels (PRP) are divided into two groups: 1) fate and transport; and 2) toxicology. The fate and transport panel addresses individual sections on, among other topics, methods of manufacture;

past and current manufacturers with data on current and historic production and consumption patterns; data on over 20 different physical/chemical properties; ecotoxicity and associated ecotoxicity values (e.g., LC_{50} , LD_{50}); natural and artificial sources; bio- and abiotic-degradation; concentrations in environmental media (including source-dominated); bio-concentration factors; various international, federal, and state regulatory levels including health, environmental, and FDA; history of accidents; and major reports. There are sections on current analytical methods (USEPA, AOAC, NISOH, Standard Methods, etc.) as well as older methods that may have been used during the time of interest. Since the database is an NLM product, there is extensive toxicological information for both human and nonhuman subjects. Most records include an 'Environmental Summary' which provides a quantitative and qualitative overview of a chemical's behavior in the environment, including photolysis, hydrolysis, bio-degradation, volatilization from wet and dry media, bio-concentration, soil mobility/adsorption, routes of exposure among others.

Each record would also identify any compounds related to the title compound, e.g., precursors, metabolites hydrolysis products, which could have significant environmental ramifications. Cross-links allow the user to determine in what other HSDB chemical records the compound of interest is also mentioned.

HSDB can be searched by name, name fragments, or CAS number. The database can also be searched by health effects, e.g., peritonitis, esophageal cancer, leukemia. The database is cross-linked to structural information and graphics (via ChemID plus).

Other NLM databases include those developed specifically for the medical/scientific community (e.g., GENETOX, CCRIS, EMIC) with hot links to the referenced papers (via PubMed). However, NLM has also developed databases to help the lay population understand chemically related environmental issues by using simple, familiar graphics. Examples are ToxTown and Household Products. Such graphic databases could be of use in jury trial situations.

The records can be accessed by 'Googling' "HSDB" and following the instructions.

Environmental Forensics, Information, Peer-Reviewed

C25 Released Petroleum Products Containing BTEX—Aerobic or Anaerobic Biodegradation

James S. Smith, PhD, Trillium, Inc., 28 Grace's Drive, Coatesville, PA 19320; and Grant DeWitt, MS, PM Environmental, Inc., 22655 South Chrysler Drive, Hazel Park, MI 48030*

The goal of this presentation is to provide a simple method to determine the type of natural attenuation that is occurring in soil or groundwater at a petroleum release site. The information may be helpful for remediation choices.

This presentation will impact the forensic community and/or humanity by demonstrating a new method of analyzing natural attenuation of petroleum releases.

Benzene, toluene, ethylbenzene, and xylenes (BTEX) are found in the petroleum products gasoline, mineral spirits, kerosene, jet fuels, diesel fuel, and home heating oil. In fresh petroleum products, the ratio of the concentration of ethylbenzene to the total concentrations of the three xylene isomers is 0.17 ± 0.05 . This value can be found in numerous references. The consistency of this ratio makes logical sense because all four of these hydrocarbon chemicals are in the class of C_2 benzenes. They have the same molecular weight and similar vapor pressures, water solubilities and soil adsorption coefficients. Thus, sampling, analytical errors and the fate and transport mechanism differences for ethylbenzene and the xylenes are canceled out by use of the ratio of their respective concentrations in any matrix.

These chemical and physical characteristics allow the relative rates of biodegradation to be measured by the ethylbenzene to xylenes ratio. Anaerobic biodegradation removes xylenes faster than ethylbenzene. This will make the ratio increase as the concentration of the xylenes decreases faster than the ethylbenzene concentration. At most petroleum hydrocarbon release sites, the aerobic biodegradation of the initial release or releases of hydrocarbon make the soil and groundwater anaerobic. Large releases of hydrocarbon will also make the soil and groundwater anaerobic, yet the ratio remains constant at 0.17 ± 0.05 due to the large amount of petroleum product at the location of the release.

Groundwater plumes of BTEX will lose toluene first then the ethylbenzene to total xylenes ratio will increase to values approaching one and greater until the xylenes are no longer present. Soils can also show this same type of fate mechanism.

There are sites where the concentration ratio of ethylbenzene to total xylenes is less than 0.12. According to the literature, ethylbenzene is aerobically biodegraded faster than the xylenes. This ratio allows one to map aerobic, anaerobic and LNAPL locations at a petroleum release site using the BTEX data. This may be of value in determining source areas of the release or releases.

A case study will be given to illustrate this concept.

BTEX, Anaerobic, Aerobic

C26 First-Order Exponential Regression of Ethylbenzene/Xylenes Ratios for Estimating Release Date

Grant W. DeWitt, MS, PM Environmental, Inc., 22655 South Chrysler Drive, Hazel Park, MI 48030; and James S. Smith, PhD, Trillium, Inc., 28 Grace's Drive, Coatesville, PA 19320*

After attending this presentation, attendees will understand how to evaluate petroleum hydrocarbon data to estimate release or significant source reduction date, support a new from old release determination, and indicate the potential for free phase conditions.

This presentation will impact the forensic community and/or humanity by adding to the arsenal of petroleum hydrocarbon release site investigation techniques, using typically available or easily obtainable chemical analysis data to investigate site conditions and release timing. This research has direct impact on who is the liable party and what funding is available for contaminant cleanup.

A model is proposed to estimate a "petroleum hydrocarbon release or significant source reduction date range" (RDR) based on groundwater time series data exhibiting anaerobic, first-order exponential biodegradation decay. Groundwater monitoring data for sites with known release or source termination/reduction dates are compared with model predictions.

Gasoline, kerosene, diesel, and heating oil have composition ratios of ethylbenzene to xylenes of approximately 0.17 ± 0.05 . Upon a release, typically aerobic bacteria rapidly use the available oxygen and drive the release environment anaerobic. Ethylbenzene and xylenes are C_2 benzene compounds that have nearly identical boiling points, vapor pressures, water solubilities, and carbon-water sorption coefficients. Therefore, the major fate mechanisms of evaporation and water washing and transport mechanism of groundwater velocity retardation treat ethylbenzene and xylenes alike. Anaerobic biodegradation will remove xylenes faster than ethylbenzene and the ratio of ethylbenzene to xylenes (EXR) in groundwater will increase with time.

Petroleum hydrocarbon biodegradation can be reasonably simulated using first-order exponential approximations. The ratios of these hydrocarbons will also follow first-order exponential approximations. Given the 1) difference in ethylbenzene and xylenes biodegradation rates and 2) similar properties and fate and transport will not significantly effect the EXR over time, simulating the EXR using a

first-order exponential approximation will eliminate the need to know the initial ethylbenzene and xylenes release concentrations and allow for modeling the observed groundwater data to predict a RDR using a minimum ($0.17 - 0.05 = 0.12$) and maximum ($0.17 + 0.05 = 0.22$) initial EXR representing a new release.

Ethylbenzene and xylenes groundwater monitoring data that exhibit anaerobic, first-order exponential biodegradation decay are used to estimate a RDR, or at least indicate the release could not have occurred after the estimated RDR, that were in reasonable agreement with known release and source reduction dates. The field examples suggest that regression analysis of post release data can be used or obtained to provide a reasonable estimate of the RDR, without the need for early time data. Historic EXR data are modeled and projected forward in time to support a new from old release determination. EXR data not showing an increasing trend and remaining near the range anticipated for a new release are associated with an example of intermittent free product conditions suggesting a means to indicate the continuing presence of free phase hydrocarbons and significant source material.

Petroleum, Release, Date

C27 The Emergence of Stable Isotopes in Environmental and Forensic Geochemistry

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After attending this presentation, attendees will understand how stable isotopes have become an important topic in many issues of environmental forensics and other related areas of forensic science.

This presentation will impact the forensic community and/or humanity by demonstrating how stable isotopes are becoming an important tool in environmental forensics. They are being used not only in environmental forensics but related topics in food science, drug abuse, arson investigations, and many other areas. This presentation will provide an overview on why this approach has become so important and how one obtains the data.

The development and commercial availability of combined gas chromatograph-isotope ratio mass spectrometer (GCIRMS) systems that permit the determination of the isotopic composition of individual compounds has led to a significant increase in the use of this approach in environmental forensic studies. This paper will provide an overview of this approach and use several examples to demonstrate the utilization of the approach to a variety of forensic and environmental problems. The examples will illustrate the use of stable carbon and hydrogen isotopes in the determination of the origin of refined hydrocarbons and other organic carbon compounds in the environment. Wherever possible the isotope fingerprints are combined with data from GC and GCMS and other evidence. However in certain cases, when looking at individual spills, such as toluene for example, stable isotopes can be used to discriminate toluene derived from different feedstock. Products such as gasoline, even if heavily weathered through evaporation, will still maintain their original isotopic signature in the weathered residue. In this manner even though the GC fingerprints of a suspected source and product in the environment will look very different, the isotopic composition of individual compounds in the two samples will still be able to show whether the samples are related or not. Engine oil samples from hit and run accident victims would be another application whereby it would be possible to relate oil spots on the victim with oil samples taken from the suspected vehicle through a combination of the isotopes and GC and GCMS. From an environmental perspective it is often necessary to determine whether a particular compound has been

undergoing biodegradation as a result of natural attenuation. It is often very difficult to do this on the basis of concentration data since a decrease in concentration may simply represent a dilution effect. However, the authors' work with compounds such as MTBE and various BTEX compounds clearly show that a decrease in concentration accompanied by an isotopic enrichment for both carbon and hydrogen is overwhelming evidence for the onset of natural attenuation. The source and fate of chlorinated solvents such as PCE, and TCE along with perchlorates compounds in the environment is an area where chlorine isotopes are starting to play an ever-increasing role in the same manner. Examples of the use of stable isotopes to discriminate several sources of PCE/TCE at an industrial site will be discussed.

In addition to the topics mentioned above stable isotopes play an important role in the food and liquor industry. For example in tequila isotopes can be used to determine whether the tequila has been adulterated from cane sugar rather than agave. Are all spices sold natural or do some contain synthetic compounds? Again isotopes play a key role in this type of study. Isotopes can be used to determine geographic source areas for drugs such as cocaine. Isotopic differences between synthetic testosterone and natural testosterone for example can play an important role in doping controversies. Arson investigations can also benefit from use of isotopes since accelerant residues can be correlated to the original product used to start the fire. Bulk carbon and nitrogen isotopes have also been used to determine the geographic origin of certain drugs.

The number of applications of isotopes to these types of problems is limited only by the level of one's imagination. Applications are in their infancy and will continue to grow with additional isotopes being utilized in the future at ever decreasing levels of detection.

Stable Isotopes, Environmental, Forensics

C28 In-Vivo Method to Characterize the Effects of Selected Contaminants & Walking Speed on Tendency to Slip During Walking

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After attending this presentation, attendees will become familiar with the history of gait studies relative to required and available slip resistance. This paper describes a gait study using a specific shoe outsole material, selected contaminants, and varying walking speeds on the tendency to slip. Force plate results are used to determine the available coefficient of friction. Portable tribometers were also used to measure the coefficient of friction of the same outsole/contaminant/walkway combination.

Tribometer testing of RCOF (slip testing) was performed on the same combination of 'test foot', walkway surface, and contaminant. The methodology employed in this study will impact the forensic community and/or humanity by allowing the authors to characterize in vivo slipping in an adult walking on a flat surface. Comparisons between tribometer and in vivo data may give insight into the validity of generalization of tribometer results to real-life situations.

Slipping, and the potential for falling, is a major public health problem in the world. In the United States, in 2003, according to the National Safety Council's tabulation of Bureau of Labor Statistics data, 174,570 people fell in the workplace on the same level, resulting in lost time from employment and significant injuries (National Safety Council 2005-2006). Biomechanical studies of gait have resulted in the

experimental determination and theoretical development of significant factors that affect the propensity for slip of test subjects during level walking (Perkins 1978, Strandberg and Lanshammer, 1981, Proctor and Coleman, 1988, Redfern and Boswick 1997, Gronqvist et al 2003). Analysis of gait, using biomechanical principles can be used to determine whether a shoe outsole/walkway surface can be slip resistant (Marpert 1996). The ground reaction forces used to characterize the tendency for slip to occur while level walking is the ratio of shear to normal forces (F_h/F_v). Under no-slip conditions, the ratio F_h/F_v is known as required coefficient of friction (RCOF) (Redfern and Andres 1984, Gronqvist et al 2001). Mathematical models have been developed to predict when a slip event is likely to occur (Batterman et al 2004). Portable tribometers can be used *in situ* to measure the available coefficient of friction between the walkway, shoe outsole material, and any contaminants present. Researchers have identified the required coefficient of friction (RCOF) as ratio between the horizontal ground reaction force to the vertical ground reaction force (F_h/F_v) as the minimum coefficient of friction that must be available at the shoe/walkway interface, during level walking, to prevent a forward slip (Redfern and Andres 1984, Hanson et al 1999). During level walking, if this required coefficient of friction is significantly less than the available coefficient of friction, the subject will be able to continue walking in an uneventful manner. Walking speed has been found to affect the required coefficient of friction (RCOF) –increasing the walking speed increases the RCOF (James 1983, Myung et al 1992). Heel velocity (generally) is forward immediately upon impact with the walkway surface, then the heel either comes to a stop or reverses its sliding direction before coming to a stop; however some researches have reported rearward sliding of the heel immediately upon contact with the walkway surface (Cham and Redfern 2001). Hanson et al attempted to develop a method to evaluate the relationship between slip resistance measurements and actual slip and fall events. The test subjects walked on a specially designed ramp. This ramp included an integral force plate, and the ramp angle could be varied (0°, 10° and 20°). Lockhart et al measured age-related gait changes by having two age groups young (18-29 years) and old (65 years and over) walk over two separate floor materials – carpet and vinyl tile. The vinyl tile was covered with motor oil (10W40) to reduce its coefficient of friction. Test subjects walked around a circular track, while in a safety harness. A remote controlled floor changer (RCFC) was developed and used to change the floor surface to either of the floor materials to provide an unexpected low coefficient of friction walking surface. This changed floor surface was placed over a force plate, allowing for the measurement of ground reaction forces during any slip event. Dynamic coefficient of friction (DCOF) measurements were made on both floor surfaces using a laboratory produced drag tester with a rubber sole shoe surrogate.

Brady et al induced slips in barefoot young healthy adults walking on a vinyl floor material contaminated with mineral oil. The subjects were blindfolded during this test. The contaminated vinyl surface was placed over a force plate. Lower body kinematics was measured using a video-based motion capture system. Burnfield and Powers (2006) investigated the relationship between slip resistance (shoe outsole/walkway) and the peak utilized coefficient of friction. This was related to the probability of slip during level walking. Test subjects were asked to walk across an instrumented force plate while their kinematics was being recorded. During some tests, the force plate was contaminated with WD-40. The available slip resistance on this contaminated surface was measured using a portable tribometer (VIT). Logistic regression analysis was used to compare the probability of slip to the difference between available and utilized coefficient (RCOF).

In the present study, a flat, level walkway was used to determine the effect of walking speed and contaminants on the tendency to slip. The test subject was a young healthy male, with no history of foot or musculo-skeletal problems. Data were collected on a 10 m long walkway. To protect the subject from falling, a safety harness was used.

The harness was suspended from a rolling frame (BIODEX Body Weight Support System), which was constrained using wooden rails to roll straight down the walkway. No body weight was supported by the system during testing; however, the harness would prevent the subject from falling. The walkway was instrumented with a 4.3 m GAITRite mat (CIR Systems, Clifton, NJ) for measurement of temporal and spatial gait parameters, and an AMTI biomechanical force platform (AMTI, Watertown, MA), model OR6-5, for measurement of ground reaction forces. The force platform was the designated ‘slip’ location. The platform surface was covered with a commercially available marble (Carrera) surface (46 x 51 x 1.3 cm). The subject’s foot motion on the force platform was recorded using a digital video camera (Canon ZX80) for qualitative analysis. The walkway was 10 m long, sufficient to allow the subject to continue walking well past the slip location without slowing. The GAITRite mat collects temporal and spatial parameters with a sampling rate of approximately 80 Hz; ground reaction forces were collected at a sampling rate of 1000 Hz. The surface conditions of this marble plate were: dry, wet (distilled water), wet (soap solution) and wet (mineral oil).

The shoes worn by the test subject were specially prepared with a Polyurethane elastomer outsole (integral sole and heel), with a ‘diamond type’ grooved pattern. These sole materials were affixed to an ‘oxford-type’ shoe. Markers were applied to the outside of the shoe to allow the video camera to record the position of the test foot. Three initial trials were conducted with the dry marble surface, no support frame, and the subject wearing his own shoes to be used as baseline data. These initial trials were used to determine the subject’s self-selected walking speed (SSWS). From this self-selected speed, a “slow” speed (80% of SSWS) and a “fast” speed (120% of SSWS) were calculated. These were used as target speeds for the test trials. Walking speed for each trial was measured using the GAITRite mat. The subject was given the opportunity to practice to allow them to acclimate to the new speed each time the speed was changed.

Trials for each surface condition (dry, wet-water, wet-soapy water, and wet-mineral oil) were collected at each speed (SSWS, Slow, and Fast). For each test, the test subject was asked to walk along the walkway. Using the handles on either side of the movable BIODEX frame, researchers pushed the frame along as the test subject walked inside this frame. The subject began walking approximately 2 meters before the beginning of the GAITRite mat, and continued past the end of the mat, over the force plate, and on approximately 3 meters past the end of the force plate. A number of trials were performed, under dry conditions, with the frame being ‘pushed’ and the test subject walking within the frame, to establish repeatability of walking speed of the test subject. Data were then collected on the test subject, wearing the supplied footwear, at each of the three walking speeds, under each of the four surface conditions. Five trials were collected for each combination of conditions. The order for conditions was kept consistent for the experiment: floor conditions were dry, then wet-water, then wet-soapy water, then wet-mineral oil; under each condition, data were collect at the slow speed, SSWS, and then fast speed. For each trial, walking speed as reported from the GAITRite system and the vertical and horizontal ground reaction forces were exported to be processed using Microsoft Excel (Microsoft Corporation, Redmond, WA). Required Coefficient of Friction (RCOF) was calculated for each sample as follows:

$$RCOF = \frac{GRF_{horizontal}}{GRF_{vertical}}, \text{ where } GRF_{horizontal} = \sqrt{(GRF_{ML})^2 + (GRF_{AP})^2}$$

The subscripts AP and ML refer to the anteroposterior (fore-aft) and mediolateral (side-to-side) directions respectively. Peak values of RCOF were noted for the braking (initial) and pushing (final) phases of the gait cycle. Peak pushing and braking RCOF were plotted against velocity for each testing condition. For trials with no slip, RCOF increased with increased walking speed. RCOF at toe-off (pushing phase) was slightly greater than RCOF at initial contact (braking phase).

RCOF was noted on dry trials, and these were compared to contaminated trials. When available COF was less than RCOF, the subject would slip. Slips were characterized as ‘heel slips’ (at initial contact) or ‘toe slips’ (at terminal stance, push off). For most conditions, toe slips were seen at a lower velocity than were heel slips.

Walkway Safety, Forensic Science, Tribometry

C29 The Characterization of the Slip-Test PIAST Tribometer by Characteristic Functions Based Upon Logistic Regression

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After attending this presentation, attendees will become familiar with newly developed methodologies to characterize tribometers using a “zero friction” test stand. Although the methodology can be utilized with any binary-output tribometer, the authors have utilized a specially modified Slip-Test PIAST. Logistic Regression is used to mathematically describe probability of a slip as a function of the indicated Available Friction.

This presentation will impact the forensic community and/or humanity by discussing research that indicates that the tribometric instrument tested (the PIAST) was not, at low friction readings (friction levels where pedestrian slips are expected to occur), a significant source of measurement uncertainty.

Flooring and shoe manufacturers, insurance companies, researchers, and forensic engineers sometimes disagree as to the import of in situ tribometer test procedures and results. The present paper describes a test methodology used to isolate the design parameters that can affect tribometric test results in a low friction environment. A low friction test stand was designed and built to reduce the effects of friction on the tribometer test results. Air bearings (manufactured by New Way Air Bearings, Aston, PA) were used in this test stand to allow a horizontal slider (containing these air bearings and sliding on machined horizontal rods) to move with essentially no friction. The tribometer ‘foot’ was covered with a material that resulted in no slippage between this foot and the mating surface of this horizontal slider. This combination (tribometer test foot in contact with horizontal slider surface) would slide with minimal frictional resistance along these machined rods. The tribometer ‘mast angle measuring system’ was modified to allow for finer adjustment of the mast of the tribometer, thereby allowing smaller angular increments to be used during these tests. A digital inclinometer was attached to this modified tribometer, allowing for angular measurements to the tenth of a degree. A horizontal force (calibrated weights) was applied to the tribometer mast to prevent the sliding (equivalent to a the in-plane (tangential) force during in situ testing) of the tribometer foot/slider combination. Specific weights were used, resulting in known horizontal forces applied to the mast of the tribometer. The angle of the tribometer mast was set such that the horizontal component of the tribometer’s applied force at contact was equal to this applied horizontal force. Under these conditions, the tribometer should not slip. Using this same weight, the mast of the tribometer was varied slightly (in either direction-closer to and further away from the vertical) and large numbers test runs were conducted to determine ‘probability function of the tribometer’s slipping or not slipping. Logistic Regression was used to characterize these test results.

The results show that, at low friction values (where slips occur), the tribometer is not the source of the bulk of the uncertainty in the measurement of the in situ friction.

Forensic Science, Characteristic Function, Tribometry

C30 Slip-Resistance Measurement of Walkway Surfaces – What Next?

David H. Fleisher, BSE, MSCE, Fleisher Forensics, 550 Pinetown Road, Suite 306, Fort Washington, PA 19034*

After attending this presentation, attendees will benefit by training on the application of current and prior ASTM consensus standard test methods for tribometers, slip-resistance measurement of walkway surfaces and, importantly, the current state of the various tribometric standards, which are presently in flux.

This presentation will impact the forensic community and/or humanity by demonstrating how walkway-safety friction measurement is an important consideration in evaluating certain slip, fall, or loss-of-balance related accidents. The monetary impact to the United States is substantial and premises-liability litigation commonly questions the walkway surface attributes.

Consensus standard test methods produced at ASTM commonly become updated, revised, or substituted to reflect new technology, research, practices, industry trends, or progress. The standardization of slip-resistance equipment and test techniques is migrating to a new approach to reflect these trends. The former slip-resistance test methods, ASTM designations F1677, F1678 and F1679, which were written proprietary based - these standards were designated for specific Tribometers. ASTM decreed that standards designated for the Mark I, Mark II and English XL were planned to be withdrawn by the end of September 2006, because these standards were proprietary rather than performance based and valid precision and bias statements were prevented from passing ASTM balloting process. New performance based standards are under development in ASTM Committee F13 with an open framework for industry to independently validate tribometers, considering monotonic performance against a predetermined suite of test surfaces, ruggedness, and precision and bias. ASTM designations F1677, F1678 and F1679 are still valid and acceptable industry tools at least until the new standards are developed, comply with ASTM consensus requirements, pass the ASTM balloting process and tribometer validation is completed.

Forensic Engineering, Walkway-Safety Standards, ASTM Standards Development Process

C31 Using Human Factors Engineering to Evaluate Existing Walkway Accessibility Standards

Alison G. Vredenburgh, PhD, Vredenburgh & Associates, Inc., 2588 El Camino Real, F353, Carlsbad, CA 92008; Alan Hedge, PhD, Cornell University, Department of Design and Environmental Analysis, College of Human Ecology, Ithaca, NY 14853-4401; and Ilene B. Zackowitz, PhD, and Jerome M. Welner, MS, Vredenburgh & Associates, Inc., 2588 El Camino Real, F353, Carlsbad, CA 92008*

After attending this presentation, attendees will Attendees to this presentation will gain an understanding of the process involved in conducting original research as part of a forensic human factors investigation as well as insight into how to evaluate the psychological or human factors that often interact with engineering issues. This presentation will impact the forensic community by demonstrating an approach to evaluating accessibility requirements.

This presentation will impact the forensic community and/or humanity by demonstrating The authors use this case study to illustrate the practical application of employing human factors research in evaluating existing standards and to provide a basis discuss accessibility in the legal arena.

The authors discuss the atypical lack of a theoretical research foundation for ADA/FHA/building code requirements for slopes and cross-slopes of walkways and ramps. The authors demonstrate the use of original research to evaluate perceptions of wheelchair users.

The FHA requires that walkways be “accessible.” The Justice Department and various disability groups have contended that walkways are “inaccessible” if they do not meet the 2% cross-slope and 5% running slope standards and have sued developers to have non-conforming sidewalks replaced.

This study was conducted to evaluate the threshold point at which slopes, cross-slopes, and their interaction are detectable to wheelchair users. It also evaluated the degree to which wheelchair users could perceive a difference in slope and cross-slope by assessing their ability to detect the relative difference between two paired walkways/ramps (one conforming, one non-conforming; See Figure 1). Participants’ perceived workload exerted in negotiating these surfaces was also evaluated.

The results indicate that the existing requirements are not supported by empirical research and are in fact inconsistent with results found by experimentation. Principal findings include:

1. Wheelchair users cannot reliably detect differences in cross-slope between a ramp at the existing standard of 2% and 2nd ramp set to up to 5%.
2. Wheelchair users cannot reliably perceive a difference in running slope between a ramp at the existing standard of 5% and a second set up to 7%.
3. When participants could detect a cross-slope difference at 6%, they still did not rate this as requiring anything more than “light” or “very light” effort to travel the length of the ramp, and almost two-thirds of the manual wheelchair users said that they would not have a problem traveling a ramp with a 6% cross slope that was almost four times longer than the test ramp.

This study provides an empirical basis for a discussion of what is accessible for wheelchair users. The findings indicate that a deviation in cross-slope from the 2% standard or in running slope from the 5% standard for a distance of up to 4 flags (4-foot sidewalk squares; the 20-foot distance of this study) would not make sidewalks inaccessible. For example, if a sidewalk had a 2% running slope and the cross-slope changed from 2% to 5% for a distance of 3 flags, it would not be inaccessible, and in fact, many wheelchair users may not be able to detect the difference. Similarly, if the cross-slope was 2%, and the running slope changed from 5% to 7%, it would not be inaccessible.

Human Factors, Environmental Design, Accessibility

C32 Vehicle Live Burns

Harold E. Franck, MSEE, and Darren H. Franck, BS, PE, Advanced Engineering Associates, Inc., 4713 MacCorkle Avenue, Southeast, Charleston, WV 25304; and Raymond Gomes, Progressive Insurance, 2926 Falkenburg Road, Riverview, FL 33569*

After attending this presentation, attendees will understand the comparison of fire evolution in identical vehicles with fires set at different locations. Temperature measurements correlated with video of the fires will be presented for four instrumented vehicle fires.

This presentation will impact the forensic community and/or humanity by aiding fire investigators in the determination of the origin and the cause of vehicular fires.

On April 24, 2006, Advanced Engineering Associates Inc., in conjunction with Progressive Insurance Company, conducted a live vehicular burn training exercise at Adesa Impact in Tampa, Florida. Four separate and distinct vehicles were ignited and allowed to burn. Two of the vehicles were allowed to burn to completion, and the other two were burned to various degrees in order to simulate real life vehicle

burns as encountered in the field. All the vehicles were fully instrumented with K-Type thermocouples and the burns were photographed and video taped. The temperatures at various locations in the vehicles were recorded. These tests were partially performed in order to dispel myths that exist about the development, evolution, and venting of the fires in vehicles.

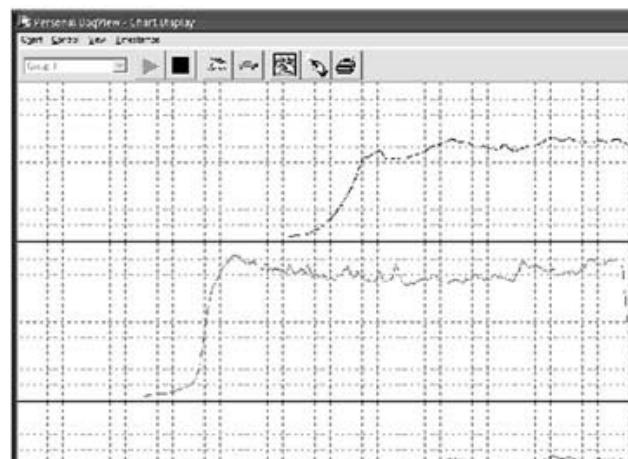
Of particular interest to the investigators was the development of fires in two identical vehicles that were started at different locations with the same fuel load and the same venting scenario. The venting scenario is governed by the ventilation factor and described by the equation:

$$H_{rr} = 750 A_o (h_o)^{3/2}$$

where

H_{rr} = Heat release rate (KW)
 A_o = Ventilation opening (m²)
 h_o = height of opening (meters)

The temperature graphs of the two identical vehicles were used to correlate the fire patterns after the extinguishment of the fires. The fire patterns were then analyzed to determine the origin of the two fires. The comparison of the two identical vehicle fires reveals that fire pattern analysis, when properly interpreted, can reveal the origin of the fire in vehicles. Fire patterns in vehicles are indicative of the fire origin even though the vehicles are completely consumed.



The other two vehicle fires demonstrate different scenarios of fire development and the effect of different venting and interior volume on the progression of the fire. The effect of a large interior volume and significant venting area produce exceedingly rapid-fire development while small volume and small venting area produce a slow fire progression. The difference is quite dramatic as the fires vary in development between ten and thirty minutes. These fire tests also verify the considerable fuel load that is present in the interiors of the modern vehicle.

The thermographs and the scenarios of the fires for each vehicle will be made available to the participants. These scenarios include the fuel load and the method of ignition for each of the fires. This presentation should aid the fire investigator of vehicular fires in the recognition and analysis of fires they investigate. The presentation will also include video clips of the live burns and pertinent photographs. A graph of one of the fires is shown below.

Fire Evolution, Fire Patterns, Ventilation

C33 Case Studies: Exploding Portable Gasoline Containers

Lori C. Hasselbring, PhD, PE, Stress Engineering Services, Inc.,
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After attending this presentation, attendees will learn the concept of flame arresters and the probability of gasoline container explosions.

This presentation will impact the forensic community and/or humanity by demonstrating the probability of gasoline container explosions in the home. A simple engineering solution to this problem is the installation of a flame arrester, which is already used in metal safety containers.

Sir Humphrey Davy developed the first miner's flame safety lamp in 1815. The Davy lamp focused on a safe way to provide lighting for coal miners, and involved the use of a perforated metal barrier (or flame arrester) to prevent the propagation of flame through a flammable vapor mixture. The principle of the Davy lamp has been utilized in various applications over the past two hundred years, including metal safety containers used for gasoline storage.

This paper describes case studies of portable plastic gasoline container explosions and fires that have occurred while emptying the container. In one example, while working at home on a science project to determine the burn rates of different types of wood fuel, a fourteen-year-old boy was severely burned after flames traveled back up into the portable gasoline container and exploded. A neighbor heard the explosion and saw flames go ten feet in the air, resulting in a spray of burning gasoline in all directions. It is shown by experimentation that a flame arrester installed in the pour opening of the portable gasoline container would have prevented an explosion inside the gasoline container.

It is also shown by experimentation that portable gasoline container explosions are more likely to occur at cold temperatures or if the light ends of the gasoline have been evaporated. For example, the saturated vapor of 40% evaporated winter-grade gasoline will ignite and explode if the ambient temperature is 43°F or below, with the greatest explosion pressure expected at about 25°F, independent of the amount of liquid gasoline in the container. A video showing the destruction of a two-gallon plastic gasoline container containing two cups of 40% evaporated gasoline will be viewed at the presentation. The possibility of a BLEVE (Boiling Liquid Expanding Vapor Explosion) occurring in a portable gasoline container will also be discussed.

Gasoline, Fire, Explosion

C34 An Investigation Into the Cause of an Explosion During the Refurbishing of Aluminum Mats Used for Portable Landing Fields

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After attending this presentation, attendees will learn the importance of preparing thoroughly for a field investigation and how microscopic details can effect the long term stability of manufactured materials that were assume to be inert.

This presentation will impact the forensic community and/or humanity by helping the forensic community to realize the importance of investigating and considering the opinions of experts that may not have been considered in early stages of an investigation. The use of the expertise of a skilled materials scientist and metallurgist was instrumental in solving a problem that appeared, on its face, to be a flammable liquids application.

Reportedly a worker was injured after striking an arc to weld an aluminum cap on a refurbished aluminum mat. The aluminum mats are used by the military as portable landing fields for aircraft. To eliminate hydrocarbon fuels as a source of the explosion, aluminum mats were sampled using passive and active activated charcoal samplers. The activated charcoal samplers were analyzed for flammable liquids by GC/MS. Mats stacked awaiting repair were cut in half and immediately sampled with two different types of portable hydrocarbon "sniffers" in an attempt to identify any flammable gas that may be present. After excluding hydrocarbons fuels as a possible source of the explosion the interiors of the aluminum mats were examined using light and electron microscopy. Analysis of aluminum chips left inside the aluminum mats from the initial manufacture of the aluminum mats 15 to 20 years prior revealed heavy oxidation leading to the conclusion that hydrogen production may have contributed to the cause of the explosion. Changing the procedure in the refurbishing process allowed time for any explosive gasses present in the aluminum mats to dissipate prior to welding.

Microscopy, Hydrogen, Aluminum

C35 Direct Observations of Arcing Through Char in Copper Wires

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After attending this presentation, attendees will understand the significance of the extent of melting in arced wires

This presentation will impact the forensic community and/or humanity by assisting in fire cause and origin determinations.

One of the consequences of a 110 or 220 volt electrical circuit being energized during a fire is that a local melting of the wires can occur. This can be produced either by a direct contact of wires between themselves or the grounded conduit, or, if the insulation that isolates the wires decomposes to enhance the electrical conductivity, the subsequent separation of the intermediary to produce a parting arc. The thermal decomposition of PVC insulation, for example, is well known to lead to the formation of distinctive regions of melting in what are otherwise relatively intact thermally annealed and oxidized copper wires. However, the general presence of this local melting cannot be broadly interpreted as a sign of electrical activity because the temperatures reached during structure fires are in some instances capable of melting copper directly. The determination of whether local melting should be interpreted as a sign of thermal or electrical activity in copper wires is typically based upon the subjective determination of the distinction of globules verses arc beads and the nature of the demarcation between the re-solidified regions (NFPA 921). The combination of the high melting point and thermal conductivity of copper means that a fairly extensive region of melting has to result from thermal damage from a fire because if only small regions are exposed to temperatures close to the melting point the substantial dissipation of heat through the wire will preclude any local melting. This is not the case for an electrical arc where the temperatures in an air gap that is created between the wires cannot be so effectively dissipated. Although the extent of melting due to the rapid increase in current in an arc between metal contacts should be fairly consistent, this may not extend to the case of arcing through char, where one might anticipate contributions from the precursory activity associated with lower excursions of current limited by the resistance of the connecting pathway. The extent of the melting and vaporizing of the wire that occurs in this case will be determined by the behavior of the resistance afforded by the residual insulation, so one might expect to see a variation in the degree of damage related to the rate at which the

heating of the insulation occurs. Since the decomposition of the insulation can also contribute to the thermal loading, there may be a practical limit to the extent of the local regions of melting and so examining the extent of the melted region of copper wire may actually permit distinction between regions of wire melted by electrical activity versus thermal activity.

In this paper the authors shall report the results of a series of experiments at different temperatures and different current densities that were used to determine the consequence of electrical arcing to copper wiring associated with the decomposition of PVC insulation. Energized circuits, containing wires of various gauges, were limited by a 15 amp breaker and exposed to temperatures that are capable of decomposing the insulation. The time to achieve a parting arc and the tripping of the circuit breaker as well as the extent of the melting that occurred was determined as a function of the temperature and wire gauge. These were then compared to the temperatures necessary to induce melting in specific lengths of the same copper wiring from which the authors were able to deduce the minimum size of the melted region produced in the absence of electrical activity.

Reference:

NFPA Guide for fire and explosion Investigations. National Fire Protection Association, Quincy Mass.

Electrical, Arc, Fire

C36 Airbag Injury Risk to Older Children Occupying the Front Passenger Seat

Christopher J. Furbish, BS, Carley Ward, PhD, and Michelle R. Hoffman, MS, Biodynamics Engineering, Inc., 15215 South 48th Street, Suite 154, Phoenix, AZ 85044*

After attending this presentation, attendees will understand the risks involved for older, pre-teen children riding in the front passenger seat of vehicles equipped with airbags with case studies of injuries sustained due to these risks.

This presentation will impact the forensic community and/or humanity by describing behavior and anatomical risks for older children riding in front passenger seats along with common injuries sustained from airbag deployment when particular risk factors are present.

This presentation identifies unrecognized injury risks from airbag deployment to older children seated in the front passenger seat. According to the National Center for Statistics and Analysis, the number of child fatalities from front passenger seat airbags has decreased since the mid to late 1990s because parents are aware of the risks and place small children, typically 5 years of age and younger, in the rear seats. Additionally, the implementation of depowered airbag inflators as a federal standard in 1998 and, more recently, the development of seat weight sensing devices likely helped to reduce child fatalities from airbag deployment. Unfortunately, first-hand observations made at locations where children are dropped off at school reveal that parents continue to allow older, pre-teen children to ride in the front passenger seat.

Four cases of children, ages 7 to 9 years old, seriously injured as a result of contact with front passenger seat airbags are presented. The injuries sustained in these cases include severe head and brain trauma, eye injury including loss of vision, and cervical distraction with complete spinal cord injury and quadriplegia. These cases involve various seat belt usage conditions, including fully lap and shoulder belted, restrained by a lap belt only with the shoulder belt behind their back, and unrestrained. The change in velocity for each vehicle in these cases ranged from 7 to 15 mph. In general, airbags are designed and configured to initially contact the chest of a 50th percentile Hybrid III dummy. This places the head and neck of short statured individuals, including older children, at greater risk of being in the path of the deploying airbag. It is well known that being in the path of an airbag

during deployment leads to significant forces that can result in severe and/or fatal injuries. In each of the cases presented, had the child been seated in the rear seat or had the airbag not deployed, their potential for injury would have been significantly reduced and, at most, they would have sustained minor injuries.

This research identifies and addresses various reasons why older, pre-teen children are at risk of front passenger seat airbag injury. Because of their small stature these children tend to sit with their knees bent at the front of the seat bottom. This can result in being closer to the airbag and out-of-position at the time of airbag deployment. Additionally, when pre-impact braking is a factor, the relatively short length of their legs prevents them from bracing on the floor, allowing a greater amount of forward movement and increasing their risk for direct contact from a deploying airbag. Furthermore, during this pre-impact braking, an older child's head/neck has a greater tendency to flex forward given the mass of their head and the relatively weak neck and upper back musculature compared to that of an adult. Behavior issues, such as wearing a backpack while seated, being out-of-position by leaning forward, and temporarily unbuckling their seat belt, can further contribute to an increased risk of injury.

The National Highway Traffic Safety Administration (NHTSA) and vehicle manufacturers recommend that all children under the age of 12 sit in rear seats. When rear seats are not available, it is recommended that the child sit properly restrained and with the seat in the most rearward position, furthest from the airbag. Current real-world observations reveal that many parents do not adhere to these recommendations and are likely unaware of the inherent risks to older children occupying the front passenger seat even when it is described in their vehicle's owners manual. Further public awareness campaigns are needed to inform the public of these risks. Investigation of possible legislation addressing this issue may also help to increase compliance.

Passenger Airbag, Older Children, Injury Risk

C37 A Uniform Method for Visual Analysis and Comparison of Airbag Deployments

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After attending this presentation, attendees will understand some of the techniques used to test automotive airbags. Attendees will be presented with an optimized testing protocol for high speed imaging of airbag deployments, which simplifies post-test analysis and allows for easier comparison with other deployment tests.

This presentation will impact the forensic community and/or humanity by demonstrating the use of a standard protocol for high-speed image acquisition of static airbag tests would benefit the automotive engineering community because it would result in better analysis and understanding of airbag deployment characteristics. Forensic engineers and scientists would be better able to identify mechanisms of airbag related injuries. Consequently, it could benefit humanity as engineers and forensic scientists work together to develop safer and more effective airbags.

A protocol for airbag tests has been established that may be helpful to the testing community at large. High-speed image analysis is an important part of identifying airbag deployment characteristics. Unfortunately, those who test airbags can often use widely varied techniques and equipment when it comes to acquiring high-speed images and analyzing them. Videos and films from different sources, therefore, cannot be easily compared. Expensive software may be needed just to derive basic data. The protocol proposed here allows for simpler and more accurate analysis, as well as easier comparison of similar tests.

The methodology for recording airbag deployments can vary from lab to lab. The frame rates of the high-speed video and films systems

can differ, as can the camera positions and lenses used. In order to get meaningful measurement data, some amount of photogrammetry is necessary. Measurements of varying accuracy can be derived using software packages that use data such as lens focal length, camera location, and objects or markers of known scale in the shot. Unfortunately, when these videos or films are shared with other researchers, all the additional data necessary to make accurate photogrammetric measurements may not be made available. Consequently, it may not be possible to independently validate the deployment data or compare results with other airbag tests.

With these problems in mind, the authors sought to create an optimized testing protocol for high-speed image acquisition of static airbag deployments. The resulting protocol, along with the considerations and advantages behind it, are discussed.

A permanent airbag fixture was developed. The fixture was constructed of reinforced heavy gauge steel. The mounting plate was designed to allow a load cell to be mounted between the fixture and the airbag to measure reaction force during deployment.

Three primary camera positions are used. Each one is perpendicular to a plane running through the center of the airbag. One camera is focused on the side of the airbag, another is focused on the front the airbag, and the third is mounted overhead, looking down at the top of the airbag. Thus, the cameras are positioned along three axes relative to the center of the airbag. The side and front view cameras are placed at a distance of at least 20 feet (6.1 meters) from the center of the airbag. Telephoto lenses are attached to the cameras in order to create a narrow field of view and compress perspective. This reduces the amount of error when attempting to measure objects that are not on the same plane. The overhead camera is placed as high as possible for the same reason.

Ideally one would like to use the highest frame rate possible to record airbag deployments, but most high-speed video cameras today require the operator to compromise between resolution and speed. Typically the operator must reduce the frame size (resolution) in order gain speed. Speeds of 1000 frames per second or higher are recommended for airbag testing. The test protocol calls for frame rates of 2,500-4000 frames per second depending on the test. The cameras are also phase locked to each other so that images from each camera are synchronized.

A solid black backdrop is used as a background to each of the primary camera views. Others have used grids or no background at all, which can make post-test analysis more difficult. Using a solid black backdrop provides good contrast between the background and the airbag fabric, making it easier for automated image analysis software to identify the airbag contour.

Prior to deployment, a black board with a white measurement grid marked on it is placed at the centerline of the airbag and recorded with each camera. Since the cameras are locked in position, the image of the measurement grid can be recorded and later digitally superimposed on the images of the deploying airbag. This allows for some basic visual analysis of the high-speed video images without image analysis software. It also can be used as a reference scale within the image analysis software.

The airbag and cameras, as well as any data acquisition equipment, are triggered by a synchronized electronic switch. An electronic flash is also triggered to visually denote time zero.

Use of a standard protocol for high-speed image acquisition of static airbag tests would benefit the automotive engineering community because it would result in better analysis and understanding of airbag deployment characteristics. Forensic engineers and scientists would be better able to identify mechanisms of airbag related injuries. Consequently, it could benefit humanity as engineers and forensic scientists work together to develop safer and more effective airbags.

Airbag, Protocol, Imaging

C38 Discrepancy Between Dummy Measured Injury Criteria During Static Out-of-Position Airbag Deployments and Actual Human Injury Outcome

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After attending this presentation, attendees will understand what the limitations are when utilizing injury criteria values obtained from anthropomorphic test devices (ATSDs) in static airbag deployment test settings.

This presentation will impact the forensic community and/or humanity by demonstrating that the established means for evaluating injury potential from being in close proximity to a deploying airbag has shortcomings and should be viewed with an eye of caution.

This presentation will help attendees understand that there are limitations when utilizing injury criteria values obtained from anthropomorphic test devices (ATDs) in static airbag deployment test settings. A real world, low-speed frontal collision will be presented where extensive (fatal) injury was produced, but the injury measures obtained from out-of-position (OOP) ATDs in static airbag testing were low and grossly inconsistent with the real world outcome.

When conducting vehicle crash testing with ATDs, accelerations, displacements, and forces can be measured for various parts of the dummy during the crash event. The National Highway Traffic Safety Administration (NHTSA) has established injury threshold values that must be met for a vehicle to pass Federal Motor Vehicle Safety Standard (FMVSS) 208, allowing the vehicle to be sold in the United States. Acceleration at the dummy head's center of gravity (cg) is used to calculate the head injury criterion (HIC). Neck loads and moments are used to calculate a neck injury tolerance called Nij. Neck tension, chest g's, and chest deflection are measured directly. In order for a vehicle to be in compliance with FMVSS, the values for these parameters must be below certain established threshold values, called injury assessment reference values (IARVs). The HIC (15 msec) value must not exceed 700 (for the 95th percentile male, the 50th percentile male, or the 5th percentile female). The Nij must not exceed 1.0 for these three dummies; however, critical intercept values used to calculate the Nij are different for the 95th percentile male, the 50th percentile male, and the fifth percentile female. The chest acceleration must not exceed 55 g's for the 95th percentile male, and must not exceed 60 g's for the 50th percentile male and fifth percentile female. The chest deflection should not exceed 2.8 inches for the 95th percentile male, 2.5 inches for the 50th percentile male, and 2.0 inches for the 5th percentile female. If all injury measures for a dummy in a given test are below the IARVs described, it is generally concluded that the chance of sustaining a serious injury to the head, neck, or chest of a human would be very low.

For vehicles manufactured after September 1, 2003, FMVSS also has requirements for an out-of-position (OOP) driver for which the fifth percentile female dummy is used. Even though no federal requirement existed for vehicles manufactured prior to that date, manufacturers were conducting static out-of-position airbag deployment testing on the fifth percentile female and child dummies. The Nij for the fifth percentile female for OOP testing uses different intercept values for calculating the Nij than for an "in position" fifth percentile female dummy.

The injury measures obtained from ATDs in static airbag deployment tests are not necessarily representative of the injury sustained by a human in a similar event.

Bench tests for the front driver's side airbag for a 1996 Ford pickup were conducted to determine the forcefulness of the airbag relative to other vehicles. Results showed that the airbag tested was typical of other driver airbags in terms of reaction force at the hub.

Additionally, static airbag deployment tests were conducted on the driver's side of a 1996 Ford pickup with 50th percentile male and fifth percentile female dummies. With the dummies' chests in close proximity to the deployment doors, the measured injury criteria were all below the established IARVs for the 50th percentile male dummy, indicating that serious injury would be unlikely. For the fifth percentile female dummy, the peak neck tension IARV of 2070 N was exceeded in both tests. In the first test, the measured value was 3,693 N and in the second test it was 2,330 N. The N_{ij} in tension and extension, N_{TE} , for an out-of-position fifth percentile female exceeded the IARV of 1.0 in one of the two tests. The remaining measures for the fifth percentile female were below threshold values. Thus, one could conclude that a small-statured human would be at risk for a serious neck injury from the deployment event, but other serious injuries would be unlikely.

Finally, these results were then compared to a real world case involving a 1996 Ford pickup. A 41 year-old male (5'7" and 170 lbs.) was involved in a low-velocity frontal collision. As a result of the low-speed frontal impact, he was on or very close to the deployment doors of the driver's airbag when it deployed. He consequently sustained extensive injuries to his head, neck, and chest including a transverse "hinge" fracture extending through the occipital bone; crush and multiple lacerations of the pons, midbrain, brainstem and cerebellum; multiple bilateral rib fractures; partial transection of the proximal descending aorta; multiple intimal lacerations of the thoracic aorta; and laceration of the posterior pericardial sac. His fatal injuries were extremely severe and clearly not predicted by the static airbag deployment tests with ATDs. It is hypothesized that the obvious discrepancy between the dummy injury measures and the actual injuries sustained is due to inaccuracies in the IARVs, reliability of the dummy measurements, and/or the failure to include any effect the vehicle velocity change may have on the injury measures.

In conclusion, injury measures from ATDs during static, out-of-position airbag deployment tests do not necessarily accurately reflect the actual injury outcome for a human.

This information helps humanity by demonstrating that the established means for evaluating injury potential from being in close proximity to a deploying airbag has shortcomings and should be viewed with an eye of caution. It is also felt that further research to isolate the reasons for this discrepancy should be conducted to help eliminate this problem.

Airbag Deployment, Out-of-Position, Injury Measures

C39 Artificial Injury Criteria and Chaotic Dummy Responses

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The goal of this presentation is to establish how injury criteria are dubious.

This presentation will impact the forensic community and/or humanity by demonstrating making the forensic community aware of the consequences of using unreliable injury criteria, which can underrate or overrate the risk of injury.

This presentation discusses the dubiousness of established injury criteria.

The public relies on the National Highway Traffic Safety Administration (NHTSA) to ensure that all U.S. vehicles provide appropriate protection to vehicle occupants. To that end, NHTSA requires that automobile manufacturers comply with Federal Motor Vehicle Safety Standards (FMVSS) before the vehicles can be sold in the U.S. One of the standards that must be met is FMVSS 208, Occupant

Protection. In FMVSS 208, anthropomorphic dummies are placed in the front outboard seats of vehicles that then experience dynamic loading in the form of a frontal impact or simulated frontal impact. Electronic data is collected from the anthropomorphic dummies during the tests. The data collected is then compared to established injury tolerance criteria such as the head injury criteria (HIC) and the neck injury criteria (Nij). The FMVSS 208 standard is designed to evaluate the safety provided by the vehicles. The safety performance of the vehicle is rated by comparing the dummy measurement data to the injury criteria threshold values. If the dummy values exceed the established criteria threshold values, the vehicle fails the test and cannot be sold in the U.S. As a result, vehicle manufacturers explicitly design their vehicles not to exceed the injury criteria. Thus, the established injury criteria values directly affect vehicle design, which makes them vital to public safety.

The first head injury criteria adopted by NHTSA, established in the early seventies, was the HIC, which was based on a variety of studies, recorded injuries, and tests. In this criterion, the dummy resultant head acceleration trace is integrated to an exponential power over a finite time interval. The integration over the time interval that provides the highest value was defined as the HIC. If the value of the integration exceeded 1000, the vehicle failed the test. This standard was later changed such that the time segment over which the integration was performed was limited. Currently in FMVSS 208, the maximum duration of the integration for HIC is either 36 milliseconds or 15 milliseconds, depending on the crash conditions. For HIC_{36} , the threshold value is still 1000; however, for HIC_{15} , the threshold value is 700.

The most unreliable criteria is the N_{ij} , especially for the child dummies (6-year-old, 3-year-old and 1-year-old). The tolerance levels used to calculate the N_{ij} are referred to as intercept values or protection reference values (PRV). Twenty-eight different PRV's have been established for the various dummies and positions, although not all of these are used in FMVSS 208. For the family of dummies, these PRV's include neck bending moments (flexion and extension) and neck loading forces (tension and compression). If a dummy were biofidelic, that is, if the dummy produced the same response as the human in a crash condition, the injury tolerance levels obtained from injured humans would be the same as the PRV values. Unfortunately, the dummy is not truly biofidelic and the child dummies only roughly approximate the responses of human children. The dummy neck where the data are obtained is not at all like a human neck. Only 11 tests have been performed on child cadavers with ages ranging from 2 years to 13 years and in only four of these tests were spinal data recorded. Obviously, children cannot be used as volunteer test subjects to study injury. As a result, the criteria for children have been developed using very limited data. Many of the child PRV's are scaled from the adult values. Even the adult dummy neck was designed to represent a human neck in a 30 mph frontal crash. Although not part of the 208 requirements, the dummy neck has even been extended to measure neck response under far different conditions and without verification. For example, injury measures using the dummy neck have been used to evaluate neck compression loads in rollovers.

Consequences of using unreliable criteria are many and serious. Depending on the event, the criteria can both underrate or overrate the risk of injury. Injury crashes that were recreated in crash tests using instrumented dummies are presented. The actual injuries are compared to the dummy measurements. In these investigations, conditions that were unsafe can appear safe based on the dummy data. The cases presented will demonstrate the gross inconsistency between the actual injury and that predicted by the HIC and N_{ij} criteria. If a crash is recreated and the dummy data indicates no injury is expected, frequently in litigation the actual facts of the case are questioned rather than the basis of the criteria or the effect of dummies' lack of biofidelity.

Dummy Biofidelity, HIC, Nij

C40 Experimental Traffic Accident in Order to Know Circumstances and Cause of Death

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After attending this presentation, attendees will understand the utility of autopsies in the event of traffic accidents, especially if the speed at the time of the impact is low.

This presentation will impact the forensic community and/or humanity by pointing out the importance of the criminal reconstructions and particularly the need for reproducing the exact conditions of the accident.

An experimental traffic accident was conducted in order to prove the responsibility of a vehicle (and the driver) in a criminal death. A 76-year-old man was the victim of a traffic accident in Spain. He was hit by a four-wheel drive vehicle (4WD) that immediately sped off. An autopsy performed in Spain shown frontal wound, occipital, thoracic and elbows lesions, and haematomas on the legs. He was immediately cremated in Spain. The French enquiry showed that he had inherited a fortune of 30 million two years ago and get married several months after.

Initially, it is very important to note that, in the international literature, no experimental studies or similar cases involving a 4WD and a pedestrian were found and the INRETS had no knowledge regarding this type of accident resulting in a fatal outcome.

In order to assist police and judicial inquiries, a reconstruction was conducted with the 4WD vehicle and a crash-test dummy (Hybrid II). Several speeds and positions were tested and all seven tests were recorded by video.

The evidence showed that the damage to the vehicle caused by a dummy of the same height and corpulence as the victim, was localized in the same place as the original impacts, provided that it was a head-on impact occurring at 30 km/hour. The cause of death was related to a violent cranio-encephalic trauma more or less associated with a thoracic trauma responsible for anoxia as a result of respiratory disorders.

The success of this experiment depended upon cooperation between the magistrate and medical examiner. It is possible that this is the first experiment of its kind conducted for a judicial purpose.

Experimental Traffic Accident, Dummy, Camera Recording

C41 Utilizing Physical Evidence to Elucidate Seat Belt Usage in Automotive Collisions Through Biomechanical Simulation

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This presentation will affect the forensic community by offering leading-edge scientific techniques to determining seat belt usage in automotive collisions. The most recent data on collision-induced seat belt markings as a function of impact severity and occupant size will assist investigators in determining usage. Investigators will also gain insight into more advanced biomechanical simulation that will aid in performing effective investigations and documenting appropriate vehicle interior physical evidence for analysis.

This presentation will impact the forensic community and/or humanity by presenting a more advanced reconstruction method to determining seat belt usage through case examples with an emphasis on physical evidence. Accident investigators will gain knowledge on important physical evidence that will aid in making these determinations and providing for a more scientific analysis.

Reconstruction of automotive collisions often includes an investigation of seat belt restraint usage by the occupants. This paper presents a two-phased research project aimed at developing more advanced reconstruction method to determining seat belt usage with an emphasis on physical evidence.

Phase one investigates the “thresholds” of collision-induced seat belt markings. An assessment of seat belt usage in a collision is typically made by considering markings on the restraint system among other factors. Prior research on seat belt markings has focused primarily on the identification and classification of typical collision-induced and non-collision induced markings and how to distinguish between them. When collision markings are absent, additional information is needed to determine usage in circumstances where the collision severity and occupant weight are speculated to not be sufficient to create such markings. The goal of this research was to generate a “linked set” of data between collision parameters, occupant size, and seat belt collision marks. Another goal was to establish a preliminary threshold of belt loading to produce typical collision-induced seat belt markings. Frontal crash simulations of varying severity were performed on a Hyge sled test system with both male and female crash test dummies. Results will be presented on seat belt loading threshold for typical collision-induced seat belt marking as functions of crash severity and occupant size.

Phase two incorporates occupant injuries and vehicle interior physical evidence other than seat belt markings. Occupant kinematics and injury mechanics are used to determine how people move and are ultimately injured during a collision. Injury criteria are means by which biomechanical engineers relate injuries to quantitative engineering parameters that may be monitored during impact simulations. Used in conjunction with biofidelic human models, or crash test dummies, injury criteria relate the risk of injury to specific loading patterns during collisions. Injuries sustained during an automotive collision represent another form of physical evidence. These injuries are most often the result of contact to objects within the vehicle. These contacts may also leave physical evidence on interior components such as scuffmarks, biological transfer or broken components. Computer simulation may be performed to elucidate occupant kinematics and quantify injury risk, via injury criteria, to various body regions. Case-specific parametric Madymo simulations were performed and compared to injury patterns and vehicle interior contacts. Injury criterion were monitored for loading to injured body regions and compared to case-specific injury patterns. Occupant kinematics are compared to vehicle interior physical evidence. Seat belt web loading monitored during simulations are compared with physical evidence found on the subject seat belt with reference to experimental sled testing results.

This presentation will affect the forensic community by offering leading-edge scientific techniques to determining seat belt usage in automotive collisions. The most recent data on collision-induced seat belt markings as a function of impact severity and occupant size will assist investigators in determining usage. Investigators will also gain insight into more advanced biomechanical simulation that will aid in performing effective investigations and documenting appropriate vehicle interior physical evidence for analysis.

Biomechanics, Injury, Restraints

C42 Low Velocity Rear-Impact Evaluation of Seat Strength and Headrest Performance Related to Neck Injury Risk

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The goals of this presentation are to present an experimental method and results for objective side-by-side measurement and comparison of motor vehicle seat strength and headrest performance as related to low velocity rear-impact neck injury risk factors for various size occupants subjected to whiplash rear-impact levels of approximately 13 KPH.

This presentation will impact the forensic community and/or humanity by providing a more accurate and scientific means for evaluating vehicle seat strength and headrest performance as related to low velocity (whiplash) neck injury risk measures. As a result of the side-by-side comparison testing, it is concluded that increased seat strength and stiffness are not the likely factors leading to reported increased cases of whiplash cited in other recent studies.

Some recent automotive studies, conducted by automotive industry researchers, have suggested that, during rear-impact, the more common, but weaker, single-recliner (SR) seat designs (i.e. about 3.2 kN strong), which tend to collapse rearward during moderate to severe rear impacts, provide improved occupant protection over the much stronger and available "belt-integrated" seat (BIS) designs (i.e. about 14.5 kN strong), for impact severities ranging from low velocity "whiplash" levels (i.e., 15 kph or less) on up to more severe rear impacts of 40 to 50 KPH. It has also been hypothesized in these studies that, because seat designs have been getting stronger since the early to mid 1990s, stronger seat designs, like the BIS types, may actually be the cause of an increase seen in current numbers of "whiplash" neck injury cases. While it may be true that there are more cases of whiplash being seen today in contrast to the 1980s and earlier, there are a number of other factors beside seat strength and stiffness which may influence the rise in whiplash claims. For instance, an increased number of larger vehicles, such as sport utility and pick-up vehicles have populated the urban and rural highways since the late 1980 time frame. These types of vehicles are more aggressive, and larger, than most economy sized family sedans and minivans, and as such they offer another potential source for contributing to an increase in whiplash injury cases. However, in light of the above industry suggestion that stronger seats are the cause of increased whiplash cases, the current study focuses on scientifically examining the seat strength and headrest performance issue.

In order to better understand the effects of seat strength and headrest performance as they relate to low velocity change (i.e., 13 kph) rear-impact whiplash situations, the current study uses an experimental, side-by-side, scientific test method and protocol (presented by the authors at the 57th Annual Meeting of the AAAS) to evaluate neck injury risk of weaker SR seat designs compared to stronger BIS designs, for various sizes of Hybrid III surrogates (i.e., a 50 kg small 5th%tile female, a 80 kg average 50th%tile male, and a average male surrogate ballasted to 110 kg) seated in a stationary sled-buck system that is impacted by a moving non-deformable sled traveling at 25 KPH. A deformable barrier is mounted to the stationary sled-buck system and provides an 8 G, 80 millisecond crash pulse similar to that recommended by the NHTSA (National Highway Traffic Safety Administration) for analyzing "whiplash" effects. Neck injury performance is based on the "percent risk of AIS (Abbreviated Injury Scale) 3+ injury" derived from the NHTSA combined load "Nij" values, calculated from the measured surrogate response.

A typical 4-door family sedan vehicle, with full interior, was used as the baseline vehicle. The driver seat position utilized the weaker SR seat design, and the right front seat position utilized the stronger BIS

design. A total of six sled-buck tests were run at a low "whiplash" severity level (13 KPH). Three tests were run for the small, medium, and large surrogates with the seat headrests in the "full down" position, and another 3 tests were run to examine the effects of the headrests in the "full up" position for all 3 sizes of surrogates. Each surrogate was instrumented with head, upper neck, lower neck, and chest instrumentation. In all cases the surrogates were leaned forward "out-of-position" (OOP) from the headrests with a gap of 5 inches, to examine effects of occupants in non-optimum seating positions for both seat types (SR and BIS).

The data and results of the "side-by-side" seat tests are summarized in several tables. Included in each table is a category for "% Risk of AIS 3+ Neck Injury Potential." What the results indicate is that for case of the headrests in the "full up" position, there is no significant difference between the neck injury risks of either the SR or BIS seat designs for all sizes of surrogates, and in both seat types there is no significant risk of neck injury. On the other hand, with the headrests in the more common "full down" position, the weaker SR seat demonstrated higher risk of neck injury for the average and large size occupants, but slightly lower risk for the small female surrogate. None of the values, however, indicated a severe risk of neck injury. As a result of the side-by-side study it is concluded that increased seat strength and stiffness are not the likely factors leading to the increased cases of whiplash injury cited in the recent automotive researchers studies mentioned above. Thus, it is recommended that additional scientific studies be conducted to look at other "whiplash" factors such as vehicle size and aggressivity parameters.

Rear-Impact, Whiplash, Seat Strength

C43 Wave-Out Airbag Fatality in a Minor Traffic Collision

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The goal of this presentation is to remind the viewer of the inherent dangers that can arise when a vehicle operator is in close proximity to a deploying airbag in a minor traffic collision.

This presentation will impact the forensic community and/or humanity by highlighting the explosive nature of supplemental inflatable restraints systems. This presentation will briefly describe the theory and design considerations that can be implemented to address airbag deployments where the risk of injury outweighs the anticipated mitigation of injury in minor traffic collisions.

Collision Overview: A two-vehicle, traffic collision occurred on South Highland in Madison County, Jackson, Tennessee. South Highland is a four-lane roadway with a center median turn lane and a speed limit of 45 mph. Just minutes before 12 noon, the female driver of a 1997 Mazda 626 4-door sedan was exiting a parking lot and was attempting a left turn to travel north on South Highland. To complete the left turn, the Mazda had to first cross two southbound traffic lanes.

While the Mazda waited to enter the roadway, a vehicle in southbound lane #2 stopped. The driver of this southbound vehicle motioned with his hand to the Mazda driver, a signal offering her the right-of-way. The Mazda driver proceeded cautiously, leaning forward to look around the left A-pillar to better see approaching traffic from her left. After slowly entering the southbound lane #2, the Mazda driver started her left turn and began to enter lane #1.

Traffic in southbound lane #1 did not slow for the Mazda as the vehicles in lane #2 had. A 1987 Ford Mustang was in southbound lane #2, and this female driver was gazing to her left searching for a furniture store. When she turned back to the traffic ahead, the Mazda had entered her lane. The Ford driver quickly steered left to avoid the impact, but it was too late.

The right front corner of the Ford impacted near the center of the Mazda's front bumper. Upon impact, the Mazda rotated clockwise in yaw. Collision damage to the Ford extended from the right front fender back to the right door, with some cosmetic damage to the right headlight assembly area. The Mazda's collision damage was most significant to the right front corner. As the Ford swept past the Mazda's front bumper, the Mazda's forward structures were pulled to the right as well as thrust rearward.

The magnitude of the longitudinal crash pulse of the Mazda was severe enough to deploy the airbags. Eyewitnesses observed the head position of the Mazda driver relative to the steering wheel. The inflating airbag thrust the driver back into her seat while the vehicle interior filled with what appeared to be smoke. The driver sat motionless.

Injuries: The inflating airbag caught the Mazda driver under her chin, as evidenced by significant abrasions and contusions to her chin and upper neck. An autopsy was performed and revealed a severe hinge-type basilar skull fracture. The skull fracture propagated through the level of the middle ear, and extended on the left and right sides to such an extent that the fracture lines nearly touched at the back of the head. The fracture was extensive enough to lift the front part of the skull. The Mazda driver also suffered a subdural hematoma in the cervical spine, a subarachnoid hemorrhage of the cerebellum, and an intraventricular hemorrhage in the fourth ventricle. The associated hemorrhages around the cervical spinal cord, brain stem, and cerebellum caused close to immediate death. Blood loss through her nose and ears, by witness accounts, was remarkable, yet witnesses still attempted to revive her. Their efforts were gallant, but were unable to restore her life.

Analysis: A thorough reconstruction was conducted to determine collision parameters using input from many sources. The point-of-impact and vehicle rest positions were documented on-site by investigating officers. A range of vehicle headings and subsequent impact angles were determined through scene geometry. A range of pre-impact speeds for the Ford was obtained through witness statements. And a range of pre-impact speeds for the Mazda was calculated using an acceleration versus distance analysis of the encroachment into the roadway from the exit driveway. Using Engineering Dynamics Corporation HVE-2D EDSMAC software, vehicle alignment, point of contact, and impact speeds were input and adjusted until the post-impact rotation of the Mazda closely matched what was measured at the collision scene.

This iterative reconstruction analysis determined the pre-impact speed of the Ford was between 32 and 40 mph, and the pre-impact speed of the Mazda was between 5 and 7 mph. The included angle between the vehicle centerlines of this oblique collision was between 115 and 123 degrees. The Mazda sustained a velocity change of 11 to 12 mph, with a PDOF of between 24 and 28 degrees. The longitudinal velocity change of the Mazda was therefore 10 to 11 mph. Post-impact rotation of the Mazda was approximately 60 to 70 degrees.

Further Study: The 3-point lap and shoulder belt was worn by the Mazda driver at the time of collision. This fact was confirmed by observing heavy blood stains in an area of the webbing that would not be exposed if the seat belt had been stowed. While load marks typically found on the latch plate or D-ring were not observed, the lack of this physical evidence in this vehicle is not an indication that the seat belt was not worn. A collision of relatively low severity and the resulting occupant restraining forces involved do not typically leave evidence of loading. In a collision of this magnitude, the risk of a severe injury would be extremely low, even for an unbelted occupant, but the driver was killed by the deploying airbag.

Conclusion: The deployment threshold of the Mazda was too low for this impact. The Mazda's airbag deployment range is 8 mph (no-fire) to 14 mph (all-fire). That is, the airbag system is designed to always deploy when the vehicle's rate of deceleration is equivalent to the longitudinal deceleration experienced by the vehicle during a frontal barrier impact at 14 mph. Furthermore, the airbag system must not

deploy if the vehicle's rate of deceleration is less than that experienced in a barrier impact at 8 mph. In the impact with the Ford, the Mazda's impact severity of 10 - 11 mph longitudinal velocity change resulted in the deployment of the Mazda airbags.

Raising the deployment threshold of the Mazda may have reduced the likelihood of a deployment in this collision. In fact, other vehicles of the same model year use a higher deployment threshold. And, dual-threshold systems were in use at that time, such that higher deployment criteria is used for belted occupants.

Tank tests performed on the driver's airbag inflator showed that it is significantly more aggressive than other vehicles in its class category. Reducing inflator output, and therefore, reducing the aggressivity of the airbag may have helped lower the risk of deployment-type injuries in this case.

Studies have been shown that short statured drivers often position their seat based primarily on their ability to reach the foot pedals. What is often ignored is the location of the steering wheel. Short statured drivers can be expected to adjust their seat to the forward end of the adjustment range, thus increasing their proximity to the airbag. Pedal extenders may have resulted in increased distance from the deploying airbag.

The airbag deployment in the Mazda was unnecessary and unreasonably dangerous. A belted driver in this collision was exposed to little risk of serious injury. But for the airbag deployment, the driver of the Mazda would not have died in this collision.

Airbag Fatality, Basilar Skull Fracture, Minor Traffic Collision

C44 Suspicious Fall of a Young Child From a Height

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After attending this presentation, attendees will learn how simulation experiments and basic principles in physics were applied to understand physical forces involved in the fatal fall of a child from a height.

This presentation will impact the forensic community and/or humanity by showing how throwing experiments based on bags of pork of similar weight to the victim helped re-enact the different forces acting on her body which caused her to fall out from the building and to land at a certain distance from the foot of the building.

On 7 October 2004, at about 4.44 am, a four-year-old girl, Sinee Neo plummeted from an upper storey of a 16-storey apartment block in Singapore. She suffered serious head injuries and died five days later without regaining consciousness. Just before she fell, her parents who had been frantically searching for her heard their daughter's piercing cries from an unknown upper storey. To their horror, they saw the dark figure of Sinee crashing through the sheltered walkway before hitting the concrete flooring 3.43 m from the edge of the building. Thirty-six year old Constance Chee, who was alone with the child just before she plummeted, was charged with kidnapping Sinee Neo from her apartment and causing her death. In the months before the tragedy, the ex-lead air stewardess had a tumultuous affair with Sinee's father. The latter borrowed some US\$30,000 from Constance, which he spent mainly on gambling before avoiding his lover's many calls to return her the sum.

Constance Chee claimed that she entered Neo's house to recover her loan but when she saw Neo sitting on his bed with a cleaver ready to attack her, Constance snatched the sleeping Sinee as a human shield. Constance claimed that she ran with Sinee up several flights of stairs, carried her near the corridor railing and the crying child accidentally fell over the railing.

As there were no eyewitnesses to the incident, the laboratory was approached to provide an expert opinion on the fall. Experiments were carried out using 25-kg bags of meat simulating Sindee's weight to determine the horizontal force required for the child to land 3.43 m from the edge of the building. A woman police officer of the same height and weight as Constance Chee helped in the experiments: tipping the bags over, projecting them out with a light force, and projecting them out with a strong determined force.

The experiments indicated that Sindee did not simply tip over the railing but had been projected out of the building with a light to strong force by an adult person from the sixth or a higher storey. It was explained in court the physics behind a falling body, and the various forces acting on Sindee's body before and during the fall.

A pediatrician testified that Sindee was too heavy a child and her hands were too small to tightly grip the 1.1-metre high railing, and the child could not have projected herself over the railing and out of the building. The defense engaged an expert who critiqued the authors' report, performed Finite Element Analysis (a computer simulation) to refute the experimental results, but did not take issue with the fundamental scientific methodology employing, suggesting instead improvements to some aspects of the experiments. After a sensational trial, the judge found Constance Chee guilty of kidnapping Sindee and causing her death. The defendant was sentenced to 13 years' imprisonment.

Fall, Height, Simulation Experiment

C45 Weather Data—Applications in Forensic Engineering Investigations

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The goal of this presentation is to show how recorded weather data can assist analysis for atypical forensic engineering cases.

This presentation will impact the forensic community and/or humanity by providing additional tools in investigating cases. Humanity is impacted by the fact that weather records provide a higher level of accuracy in the engineer's analysis and greater confidence in the results.

The use of weather data is a routine and common practice in forensic engineering investigations. Organizations such as the National Weather Service (NWS) and National Climatic Data Center (NCDC) provide recent and historic data for hundreds of individual weather stations. This data is frequently used in analyzing structural failures that may have been caused by high winds, ground snow depths, and precipitation. Records pertaining to phenomena that obscure visibility, such as fog and direct sunlight, are used in accident reconstruction. Weather data can also be used for less common cases where assessing the capability of a mechanical system is pertinent. Two such cases will be examined in this presentation.

The first case involves a claim of ice formation at an outdoor car wash. While ice would be expected during cold weather, this particular car wash was equipped with a hydronic snow-melting, or radiant heating, system. This system included pipe embedded in concrete that contains a heated solution flowing through a closed loop. The fluid produces heat that radiates into the concrete and serves to melt ice and snow that have accumulated on the surface. A component in designing radiant heating systems is the determination of the heating requirement. This requirement is set forth by the ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) HVAC Applications Handbook.

The heat flux required at the snow-melting surface " q_o " is determined by the following equation:

$$q_o = q_s + q_m + A_r (q_h + q_e)$$

The sensible heat flux " q_s " is that which is required to raise the temperature of snow falling on the slab to the melting temperature. The latent heat flux " q_m " is the heat flux required to melt the snow. These quantities are based on recorded dry bulb temperatures and snowfall rates. The snow-free area ratio " A_r " is used to reflect the insulating effect of partial snow cover.

The convective and radiative heat flux " q_h " through the slab is examined for the snow-free surfaces. This quantity is based on the recorded temperatures and wind speeds near the slab surface. The evaporation heat flux " q_e " is the heat required to evaporate water from a wet surface. Temperatures, wind speeds, and humidity levels are used to compute this quantity.

The claim involved a slip-and-fall accident inside a bay of the car wash on a day with below-freezing temperatures. Witness statements on the day of the accident and a photograph of the car wash bay the day after the accident support the contention that ice formed in the area of the fall. Subsequent analysis determined that the radiant heating system was on during the time of the fall. Testing performed after the accident revealed that the system adequately heated the slab above freezing temperatures. However, the weather conditions during the testing date were not comparable to the day of the accident.

The heat flux analysis was performed for the day of the accident, where ice was reported to have formed, the day after the accident, where photographs documented the ice formation, and the day of the testing, where it was determined that the system was adequate. This analysis accurately predicted that the heating system would not have been sufficient to prevent ice formation on the day of and after the accident. Moreover, the analysis showed that the heating system would have adequately heated the slab on the day of the testing.

The second case involves allegations that roof improvements caused damage to a residential HVAC system. The home contained three separate attic spaces and two cooling systems. The roofing tiles were replaced during a month in early spring. The roof replacement involved replacing the powered attic vents with continuous ridge vents. The original construction included only two powered vents, which left one attic space without outflow air. It was alleged that the new ventilation system was inadequate, which produced excessive heat in the attic and caused the refrigerant lines to "freeze up."

The cooling systems were repaired prior to the inspection of the home. Moreover, the HVAC repair company did not adequately document the work performed to the units. The dates of repairs did not coincide with the installation of the vents. The failures of the HVAC systems occurred in late summer, several months after the roof was completed.

An analysis was performed in accordance with the ASHRAE Fundamentals Handbook and an airflow model for attic thermal performance devised by the Florida Solar Energy Center. The following equation details the total mass flow rate " m_{tot} " based on observed conditions:

$$m_{tot} = R \sqrt{m_{buo}^2 + m_{wind}^2}$$

The total airflow is driven by the mass flow rate in the lower attic caused by buoyancy " m_{buo} " and the wind-driven mass flow rate " m_{wind} ". The "R" variable is based on the increase in flow caused by the larger soffit inlet area as compared to the ridge outlet area. These quantities are based on ambient temperatures and wind speeds recorded by nearby weather stations.

The analysis was performed for the time period extending from early spring to late summer. Airflow rates for each day were computed given the new ridge/soffit ventilation system. These results were compared to the maximum possible airflow rates produced by a powered ventilator. The analysis showed that the ridge/soffit ventilation system consistently outperformed the original system by at least 40% to 80% for

the loss dates. These results represent a worst-case scenario as the new system was compared to a powered fan that was continually running. The original powered fans were activated by a temperature switch. Thus, airflow would only be forced out of the attic when the temperatures reached a sufficient level. The conclusions reached by the mass flow analysis revealed that the new ventilation system improved conditions in the attic spaces. Thus, the claim that the cooling system was overloaded due to excessive attic temperatures is without merit.

The above cases detail the usefulness of weather records in forensic engineering investigations. The cases are relatively uncommon and may provide attendees with additional tools in their professions. Moreover, the weather data are derived from independent and reputable sources, which will connote similar qualities to the engineer's work.

Weather Data, Heat Flux, Mass Flow Rate

C46 Government Certification: Truth or Dare?

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After attending this presentation, attendees will understand the need for forensic mishap investigators to examine government certification criteria and their acceptance practices, and uncover enhancements to mishap probabilities that bureaucrats overlook.

This presentation will impact the forensic community and/or humanity by generating skepticism among those forensic practitioners who are tempted to accept uncritically certification to standards by government regulatory agencies, and motivate them to explore in depth the details of the agencies' actual certification practices.

U.S. Federal Aviation Regulations (Title 14, US Code of Federal Regulations, Parts 1 – 199) are among the most highly detailed specifications in the federal regulatory compendium. Nonetheless, fatal aviation accidents continue to occur which are traceable to incompetent federal regulators, regulations and/or regulatory processes despite investigative attribution to other "causes."

Cases of fatal accidents will be presented involving a single airplane model to which the US FAA improperly issued certification, after the agency's certification managers had accepted uncritically a faulty affirmation by the UK CAA that the airplane met applicable US certification criteria.

The aircraft was bought by the US Air Force from a UK manufacturer. Contractual specifications required that the airplanes be granted certification under US civil aviation regulations (Title 14, USCFR Part 23). After three fatal accidents resulted in six fatalities in two years' operation, a detailed review of the design by an independent contractor to the USAF revealed more than a dozen exclusive instances in which it failed to meet US certification criteria. *Post-facto* discovery revealed that the FAA had based its certification on assurances by the UKCAA that the airplane met US requirements. The USAF trainer was a "derivative design" significantly modified from prior models. Because it was "derivative," the UKCAA accepted the manufacturer's assertions that the design modifications had been tested and found to comply with the US certification criteria. In fact, they were based on "analyses" by persons who had not previously designed *ab initio* a powered airplane, and despite warnings by the manufacturer's Chief Test Pilot that the derivative design had serious failings.

Government certification cannot be accepted uncritically as assurance that an approved product actually complies either with regulatory criteria, or that regulatory specifications fulfill real-world performance requirements. Competence, both of the specifications and of the persons who draft and apply them, must be subjected to critical examination after mishaps, and precedent to litigation.

Government Certification, Latent Hazards, Mishap Investigation

C47 Defining Sharpness for Safer Products

Victor A. Popp, MS, 75 Gardner Street, Hingham, MA 02043*

After attending this presentation, attendees will understand standards that exist for measuring sharpness of edges, how to measure and define sharpness when standards do not exist, and how to devise practical test methods to prove a point.

This presentation will impact the forensic community and/or humanity by helping attendees think about liability and product safety, as well as see how practical test methods can be devised when information and standards are lacking.

Sharp products are often injurious, and there is little information available to the forensics engineer who is trying to determine exactly how sharp an injurious product is. Lawsuits can result when debilitating injuries occur from contact with sharp product edges.

There are products that are supposed to be sharp such as knives and razors; and products that are not supposed to be sharp such as consumer goods and toys. There are few published standards that can be applied when trying to determine just how sharp an object is. In addition, there are huge liabilities when products injure consumers who inadvertently make contact with a sharp edge. Often life changing catastrophic accidents result when consumers perform seemingly innocuous tasks using products under the wrong circumstances.

Manufacturers often testify that their product was not sharp, or could not be made less sharp. These arguments often are absurd, given the injuries seen. The difficulty of determining sharpness is not to be underestimated. Even well meaning manufacturers struggle with how to define a sharp edge, and how to determine if their products pose a cutting hazard.

This presentation will educate the reader on:

- Available sharpness standards and limitations
- The process of cutting (i.e., how and why materials cut)
- Different types of stresses (axial and shear)
- How these stresses relate to the different types of cutting (press cutting, shearing, tearing, chopping; abrasion)
- Devising a practical test method to determine how to prevent sharp products

The audience will also get a glimpse into how a forensics engineer can devise his or her own practical test methods when industry standards are not readily available. They will also be exposed to engineering methods that can be used for determining overall product safety.

Sharpness, Cutting, Testing

C48 Uncertainty Issues in Tribometric Testing: Isolating the Contribution of the Tribometer

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After attending this presentation, attendees become familiar with the concept of measurement uncertainty, and how it differs from error; how uncertainty is an aggregate function of the many individual sources of measurement uncertainty, and how measurement uncertainty relates to tribometric testing in Walkway-Safety analyses.

This presentation will impact the forensic community and/or humanity by demonstrating how the fact that the noise inherent in tribometric testing is not due to the fact that the testing instrument is in some way problematic implies that standard statistical measures should be able to address the variability. (That's the Good News.) The Bad

News is that sample sizes larger than often used in WSTT may well be required, which would certainly add to the cost of such testing.

Tribometric testing in the field of Walkway-Safety is the testing of the friction between a walkway surface (or a walkway-surface surrogate, called a *test surface*) and a shoe bottom (or shoe-bottom surrogate, called a *test foot*). There is significant controversy concerning the very appropriateness of walkway-safety tribometric testing (WSTT), where opinions range from—on one hand—tribometric testing is no different than measuring a voltage using a voltmeter, to—on the other—that tribometric testing is worthless and cannot come close to meeting the scientific certainty required to pass the Daubert threshold. In a related controversy, some, for various reasons, refuse to characterize the numeric results from WSTT as coefficients of friction, rather, referring to the results as *slip-resistance* coefficients. What is remarkable indeed about those who engage in this (and we're being charitable here) debate is the complete lack of empirical or theoretical justification for the positions taken; the debate is more akin to a theological, T-shirt wars dispute rather than something based upon scientific or engineering evidence.

The essential argument of those who argue the position that Walkway-Safety tribometric testing is worthless (the folks with **NO** boldly printed on their T-shirts) is that the testing of the friction between the walkway shoe surfaces is so noisy, i.e., unreliable, that the results cannot get over the scientific-certainty threshold. The least dogmatic of the **NO** group argue that protocols and procedures are not yet refined enough to be scientifically certain, and that, over time, and with work and luck, WSTT can be expected to take its place in the armamentarium of Walkway-Safety analysts. The most dogmatic of the **NO**'s argue that the very notion of measuring friction between two surfaces separated by a liquid at their interface, modeling a person walking on a wet floor, is inappropriate because "the slip resistance of a floor when wet is unknown and unknowable."¹

The authors have been and are involved in rigorously characterizing the response of a specific tribometer, i.e., the Slip-Test PIAST using experimentation and logistic regression. The results of that work appear in a separate paper. This paper places that work in the broader context of WSTT.

Measurement Uncertainty in WSTT stems from a number of factors, some of which may be correlated. Some of the more significant factors are the variability from point to point in the floor (or test surface), the variability in the shoe bottom (or test foot)—either from shoe bottom to shoe bottom or over time), the variability in any contaminant (either composition or quantity), and the variability of the tribometer itself. If the variability of the tribometer were a significant component of total uncertainty, this would complicate the measurement process.²

Experiments using the PIAST conclusively show that, at least with respect to the PIAST, the measurement uncertainty inherent in the instrument is a relatively small factor in the total uncertainty inherent in tribometric testing. In other words, it seems that the variability observed in WSTT stems from the fact that the authors were observing a noisy process, and not because the tribometer itself is problematic.

References:

¹ While the position of the former group is, at least, arguably correct, the position of the latter is incorrect on its face. If wet-surface friction measurement is (a) inherently "unknown and unknowable," then one could not measure the friction of an oil-lubricated crankshaft (something that's been routinely accomplished for generations); if (b) some wet-surface phenomena (like the frictional resistance of a crankshaft spinning in oil-lubricated bearings) is measurable and some (like a pedestrian walking on a wet surface) are not, then those taking the position are incorrectly asserting that the difficulties in measurement are impossible to overcome, making a question of *degree* into a question of *kind*. In short, even if (and the authors do not agree with this position), how to measure wet-surface friction is perhaps *unknown*, that cannot imply that it is *unknowable*.

² The uncertainty of a measurement process is often characterized by its Standard Deviation. For example, if a quantity Y is a function of a set of variables $\{x_j\}$:

$$Y = f(x_1, \dots, x_n)$$

where component i has the (typical) mean and standard deviation)

$$\bar{x}_i = \frac{1}{n} \sum_{k=1}^n x_{ik}$$

$$s_{x_i} = \sqrt{\frac{\sum_{k=1}^n (x_{ik} - \bar{x}_i)^2}{n(n-1)}}$$

then, depending upon the structure of $f(x_j)$, the aggregate Uncertainty can be found. For the simplest case, if the n variables are uncorrelated and in linear combination:

$$y = a_1 x_1 + a_2 x_2 + \dots + a_n x_n$$

then the Aggregate Uncertainty, again assuming that the Uncertainty of the i th component can be characterized by the Standard Deviation of its Average, then

$$u_{\text{aggregate}}(y) = \sqrt{\sum_{i=1}^n a_i^2 s_{x_i}^2}$$

More complex situations, including correlation between factors, can be addressed by using a Taylor-series approximation.

(See <http://physics.nist.gov/cuu/Uncertainty/combination.html>):

$$u_{\text{aggregate}}(y) = \sqrt{\sum_{i=1}^n \left(\frac{\partial f}{\partial x_i}\right)^2 u^2(x_i) + 2 \sum_{i=1}^{n-1} \sum_{j=i+1}^n \frac{\partial f}{\partial x_i} \frac{\partial f}{\partial x_j} u(x_i, x_j)}$$

Uncertainty Analysis, Tribometric Testing, Forensic Engineering

C49 Analysis of MiniDV Recording Date/Time Information

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After attending this presentation, attendees will learn about a characteristic of MiniDV digital video recordings that may assist the forensic video examiner when conducting authenticity examinations, matching recordings to recorders, and performing other forensic analyses.

This presentation will impact the forensic community and/or humanity by setting forth theoretical and practical information regarding an analysis technique that will aid the forensic audio/video community when conducting forensic examinations of submitted MiniDV recordings.

The MiniDV digital video format provides excellent video and audio quality on a relatively small tape format and has proven to be a versatile media for personal, professional, and investigative recordings. Unlike consumer analog video recordings, MiniDV recordings usually contain metadata along with the recorded video and audio information. This metadata can include information about the camcorder's settings at the time that the recording was made (e.g., exposure, white balance, shutter speed, aperture, etc.) and/or the recording date and time, using the camcorder's internal clock.

The overall digital data stream of a MiniDV recording contains separate sectors of data including the Insert and Track Information Sector, the Audio Sector, the Video Sector, and the Subcode Sector. The metadata mentioned above is contained within the Video Sector in the auxiliary video data (VAUX) portion of the digital stream. The VAUX portion is present ten (10) times per video frame for the NTSC DV standard and twelve (12) times per video frame for the PAL DV standard, resulting in 299.7 occurrences of the VAUX data per second for the NTSC standard and 300 occurrences per second for the PAL standard (based on the video frame rates of 29.97 for NTSC and 25 for PAL). Therefore, it follows that each second of the recording time information (for a continuous recording) is present approximately 300 times in the data stream.

Research and detailed analysis by the authors revealed that the recording date and time information is represented in the VAUX data by six (6) encoded bytes, with one byte each for the day, month, and year of the date and for the hours, minutes, and seconds of the time. Based on this information, the authors developed a script for counting the number of occurrences of each unique recording date and time stamp and for converting the encoded bytes to their decimal equivalents, which ultimately provides a detailed overview of the recording date and time information contained in a recording.

The script was applied to a submitted PAL MiniDV recording produced on a Samsung camcorder, and it was determined that the number of occurrences of each second of the recording date and time information varied between 264 and 336, in multiples of twelve (12). This variable pattern deviated widely from the nominal 300 occurrences per second, when analyzed second-by-second. However, taken as a whole, the number of occurrences averaged out to 300 per second of time information.

The script was then applied to recordings produced on a variety of PAL and NTSC MiniDV camcorders/recorders from various manufacturers including Canon, Panasonic, and Sony. These analyses were conducted in an effort to determine whether the eccentricity in the recording date and time information encountered in this particular case was unique.

The results of this study will be presented as well as how the forensic examiner may utilize this analysis of the recording date and time information to their advantage when conducting video authenticity examinations and when determining whether a recording was produced on a particular camcorder/recorder.

Video, Authenticity, MiniDV

C50 Forensic Examination of Video-Information Extracted From Digital CCTV-Systems and Phones

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After attending this presentation, attendees will understand what kind of examinations can be done with digital CCTV-systems and for video extracted from other devices such as phones, and what the limitations are.

The issue in examination of CCTV systems is that there exist many different formats and it is not standardized. With the examination of a new system, this presentation will impact the forensic community and/or humanity by demonstrating how new methods should be tested and validated.

Most new CCTV-systems have been changed from analogue video to digital format. The information from these systems is often used as evidence in court or to visualize what happened at a given time. Since more CCTV systems are placed on streets, shopping centers and many other places, often these systems will have information that is of interest

as what actually happened during a particular event. The CCTV-systems can be from government or from private companies; however, digital video is also presented as evidence from other sources, as mobile phones or CCTV-systems that are installed by individuals.

Sometimes the commercial systems have standards such as MPEG-2 or JPEG streams implemented on them. However, if the systems are proprietary, they might have implemented other methods for storing the information on digital media. By analyzing the raw data, more information on the method of storage is available. Nowadays many of these systems are hard disk recorders, which store information for a given time on the hard disk and then overwrite the hard disk with new information.

An issue compared to the analogue systems is the digital compression that is used. Often the digital compression causes the introduction of artifacts into the video streams. This should be taken into account when making a comparison with a person or doing measurements in the image.

It is important that the evidence is extracted in a proper forensic manner. There exist guidelines from different organizations such as ENFSI, SWGDE, IOCE, and ACPO for analyzing digital evidence, which are also appropriate to the hard disk recorder. One should also take into account the time and date stamps that are used in these system to make a time line analysis. If a severe crime takes place, it is important that all CCTV-information is extracted from this system as soon as possible, since the information might be overwritten. Also the education of the persons that collect this evidence should be taken care of, since due to the many different systems that exist, it is with some of these systems easy to erase the evidence by accident.

The use of biometric software for face comparison, or any other biometric feature is not feasible at the moment in most cases, since images from these systems are typical not under standard conditions. In most cases the examination of the video streams is manual, or with some help of software that will help the examiner to look faster through the video.

Examinations of these systems often require the proprietary player from the manufacturer from which the information is extracted. It is important that all information recorded is really shown during the display of the evidence. Different CCTV-system software is examined and a database is developed for law enforcement.

Sometimes other sources are also used as evidence such as a crime recorded with the camera available on a cell phone. In these cases it is important to examine the integrity of the recordings. It is also possible that erased parts of the memory stick should be examined. When the file is not complete, and headers are missing, efforts should be made to repair the video file. In this presentation cases and methods will be presented for repairing video streams and conducting further analysis.

CCTV, Cameras, Video Streams

C51 A Validated, Admissible, Computational Method for Detecting Electronic Authorship

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After attending this presentation, attendees will become acquainted with a validated, admissible method for determining authorship of electronic documents including email, blog posts, and chat-room messages.

This presentation will impact the forensic community and/or humanity by demonstrating how the ALIAS method is useful in criminal and civil investigations including cyber crimes, homicide, and terror threats. The ALIAS method allows investigators to obtain essential evidence and, because it is reliable and validated, testimony based on the ALIAS method has been admitted without any restrictions after a *Daubert* hearing and also under the *Frye* standard.

In an increasingly electronic society, the authorship of electronic texts can be key in the investigation of many different types of crimes and civil infractions. A suicide note left on a home computer attempts to cover a homicide. Anonymous emails over the corporate network attempt to ruin a supervisor's reputation. Anonymous "tell-all" letters attempt to scotch a corporate merger. Pedophiles leave an electronic trace in their seduction of children on the web. All of these scenarios and many more demonstrate the importance of a validated, admissible method for determining the authorship of electronic texts. Further, electronic documents significantly differ from handwritten documents, with differences that can disable methods based on handwriting examination (such as forensic stylistics). ALIAS (Automated Linguistic Identification and Assessment System) is computational-linguistics software which analyzes the syntactic patterns, syntactically-classified punctuation and word lengths of texts from which numerical output is statistically analyzed using a leave-one-out, cross-validated discriminant function analysis (Chaski 1997, 2001, 2005). ALIAS has been validated by experiments independent of litigation, at the document level. Using sufficient documents to obtain approximately 2000 words/100 sentences from each of ten authors, ALIAS obtained 95% accuracy; that is, 95% of the documents were consistently classified to the correct author in the ten-author set (Chaski 2005). More recently, ALIAS has been validated independent of litigation, at the sentence level. Using exactly 100 sentences from each of ten authors, and comparing 100 sentences of one author to 100 sentences from another author, ALIAS obtained 85% accuracy; that is, on average over the 10 authors, 85% of each authors' sentences were consistently classified as belonging to the correct author. These results demonstrate the utility of the method even in chat-room scenarios.

The ALIAS method enables investigators to obtain essential evidence against cyber-criminals and other criminals who make use of electronic texts. The method has been used to identify the authors of blog posts, the author of threatening letters and the author of a phony suicide note. The ALIAS method has also been admitted into trial testimony under the Frye standard in Maryland (1998) and also after a *Daubert* hearing in the Federal Court of the District of Columbia (2001).

Computer Forensics, Authorship Identification, Questioned Documents

C52 Pitting Occurrence and Mechanisms in 1018 Steel by Various Explosives

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After attending this presentation, attendees will understand the mechanism and onset of explosive-driven pitting of metals.

This presentation will impact the forensic community and/or humanity by investigating the mechanisms by which explosive pitting occurs.

This study was conducted to observe the pitting and cratering of 1018 steel witness plates, which had been subjected to the detonation or deflagration of an energetic material. Six common energetic materials: ammonium nitrate mixed with fuel oil (ANFO), composition C4, nitroglycerine based dynamite, trinitrotoluene (TNT) flake and two low explosives, black powder and smokeless powder were used in this study. The energetic materials were packed into 2" inch inner diameter schedule 40 steel pipes of varying lengths. The lengths were varied in order to achieve the same TNT equivalent, of 0.81 lbs, for all tests. Each energetic material was tested three times, for a total of 18 tests. The pipes were threaded on one end only, the open ended pipe was secured to a 3" by 3" by 0.25" thick 1018 steel witness plate, which had been

ground with 80 grit SiC paper in order to remove surface oxides present after processing. This test setup allowed for direct contact of the explosive with the witness plate. The energetic materials were then hand-packed into the pipes and end caps, which had been drilled out to allow for the introduction of a detonator (for the high explosive tests) or a squib (for the black and smokeless powders) were secured on the threaded ends of the pipes. The test devices were shot at the Energetic Materials Research and Testing Center (EMRTC) at the New Mexico Institute of Mining and Technology.

The 1018 steel witness plates were collected after each explosive test, photographed, and the number of pits found on the surface counted and recorded. The plates were then sectioned to reveal the cross-section, ground using standard metallurgical wet grinding methods to 1200 grit SiC paper, polished with alumina slurries of 5 μ m and 0.3 μ m, etched using a mixture of nitric acid and ethanol, and imaged using an optical microscope. After imaging in the optical microscope, the samples were prepared for and taken to the scanning electron microscope (SEM) and again examined. The pit geometry, mainly depth and aspect ratios, was examined, and special attention was given to the areas directly below visible pits, which were scrutinized for any signs of a microstructure which would be indicative of the metallurgical reason for pitting, be it melting, denting, jetting caused by the energetic material, or a combination of the three.

By examining the occurrence and geometry of pitting induced by various energetic materials and the microstructure of the metal samples, theories for the mechanism by which this pitting occurs may be advanced.

Explosives, Pitting, Cratering

C53 Detecting Problematic Casting Defects in Nonferrous Components

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Upon completion of this presentation, participants will have a clear view of the unique defects that can occur in nonferrous castings, especially die castings, which can cause product failure and a serious accident or breakdown. Ways to detect internal defects are described, and participants will be able to seek the high-energy x-ray images that are typically required in both inspection and in forensic engineering.

This presentation will impact the forensic community and/or humanity by creating an awareness of a subtle failure mode that can cause both minor and major incidents and accidents with no prior warning. Being aware of the pre-failure conditions, and with the knowledge that inspection technologies are available, forensic scientists and forensic engineers may be able to avert future failures and reduce both property and human losses.

Product or part failure is often due to crack formation caused by excessive loading or cyclic stress resulting in fatigue. This is seen frequently in nonferrous castings, especially those produced by high-pressure die-casting where porosity and inclusions present ever-present quality issues. The objective of the presentation is to make the forensic engineer aware of the failure modes of such castings, and to impart a strategy for detecting and analyzing porosity and inclusions as causal agents. Practical procedures using x-ray imaging are indicated.

Die casting of nonferrous alloys, especially those of aluminum, zinc, and magnesium, is the manufacturing method of choice when large quantities of near-net-shape product are needed quickly for mass production. Molten metal is injected into steel dies or molds under very high pressure and with fast cycle times. Part failure can be catastrophic when unseen defects concentrate internal stress to initiate cracks that can propagate rapidly. The many factors involved in die-casting create

substantial manufacturing and quality assurance challenges. These are described, and failure modes related to manufacturing and inspection processes are identified. Imaging techniques based upon high-power x-ray digitized files offer a way to improve both quality control and forensic engineering analysis after a significant failure. Firearm parts are used as a test case. Automotive examples are also described which illustrate the procedure. Porosity can lead to part rupture under pressure loadings, and can also cause fluid leakage in high-pressure hydraulic lines. Porosity in excess can effectively reduce cross-sectional area and amplify shear stress to create plastic deformation and breakage. Global supply chain practices, especially offshore out-sourcing, make casting failures more likely since some foreign inspection and quality assurance practices may be both opaque and substandard. Some useful remedies are suggested.

It is likely that forensic engineers, more aware of the modes and probabilities of nonferrous casting defects, will be better able to identify resultant failures and to push for remedial action in the manufacturing process. Consumers rely upon manufacturers' claims of high quality, which may not be valid in some supply chains, and failures in some commonplace products may result in injury and death.

Castings, Defects, Failure

C54 A Novel Sensor for Post-Blast Explosive Investigations

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After attending this presentation, attendees will understand the design and functionality of a new explosive detection sensor.

This presentation will impact the forensic community and/or humanity by demonstrating the basic research being conducted on a new type of explosive sensor.

A new type of optical chemical sensor has been developed for highly sensitive, in-situ detection of explosives. The sensor is comprised of a dense silica thin film grown on the straight-cut endface of a standard, 125 μ m telecommunication optical fiber. Silicalite is an all silica MFI type zeolite with an effective pore size of 0.55nm. MFI zeolite is hydrophobic and selectively absorbs organics of appropriate molecular size. The sensor device operates through measuring the optical refractive index or optical thickness of the coated zeolite film that changes in response to the adsorption of molecular species in its structure.

This sensor has previously been shown to detect the presence of trinitrotoluene (TNT) in a He carrier gas, but has yet to be tested for use in post-blast situations. Bullseye smokeless powder was burned in a chamber and samples of the products of this reaction were collected. These samples were then introduced into the sensor apparatus using helium as an inert carrier gas. In this work, the response of the sensor to the introduction of smokeless powder byproducts in helium carrier gas is shown.

Explosives, Sensing, Zeolite

C55 Image Rectification Using Three-Dimensional Models

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After attending this presentation, attendees will understand how to make an image rectification using three-dimensional models.

This presentation will impact the forensic community and/or humanity by demonstrating a new method for rectification of photographs that makes it possible to handle images that cannot be handled with traditional methods.

Rectification of images at an oblique angle has appeared to be very useful in forensic analysis. This technique is often used in investigations of traffic accidents for providing top view images of skid marks. The three main rules to rectify a photograph are: there need to be four markers in the scene; the real world distances between these markers need to be measured; the surface needs to be flat. With this information a photograph can be rectified and a top view can be created.

However, in some occasions, there are not enough points in the photograph that can be used or the surface is not flat. In these cases it is not possible to rectify these photographs with traditional software and photogrammetry. In this presentation the authors explain the use of a three-dimensional model for the rectification. After projecting the original photograph on the three-dimensional surface of the model, the surface of interest can be viewed from a different angle. In this way a rectified image can be produced. This technique was used successfully in traffic accident reconstructions, bloodstain pattern analysis and measurements on break and entry traces. This technique will be explained by showing two case examples.

Back Projection, Rectification, 3D

C56 Downed Power Lines and High Impedance Faults and Their Role in Electrocutions and Injuries

Helmut G. Brosz, PEng, Brosz and Associates, 64 Bullock Drive, Markham, ON L3P 3P2, Canada*

After attending this presentation, attendees will understand methods for dealing with the ramifications of high impedance faults.

This presentation will impact the forensic community and/or humanity by demonstrating the dangers of high impedance faults and, if undetected, the serious public safety hazard they pose.

A distribution primary fault, which cannot be detected by ordinary overcurrent or ground fault protection, is called a high impedance fault (HIF). These faults can occur when a conductor comes in contact with an object such as a tree, or falls on a surface of poor conductivity (e.g., ground or asphalt). Typically, a high impedance high voltage fault exhibits arcing and flashing at the point of contact.

High impedance faults generally do not create imminent danger to power systems due to the fact that the magnitude of the fault current generated is too low to harm most electrical apparatus; however, undetected HIF's can cause fire, electric shock or death. The significance of these hard to detect faults is that they represent a serious public safety hazard as well as a risk of arcing ignition for fires.

HIF detection devices are becoming available to utility companies, but these detection devices require an extended time (sometimes up to a minute) to reliably differentiate an HIF from a normal load disturbance. Field-testing is one solution to detect these anomalies; however, laboratory testing using previously recorded high impedance fault and feeder load waveforms is the most economical.

Downed power lines can also carry an electric current strong enough to cause serious injury or possibly death. Dangerous currents can be transmitted through materials other than just power lines such as a wooden pole, a kite, puddles, or other normally poor conducting material. The authors will be exploring several cases where downed power lines and streetlight failures caused death and injury and fires while the fault currents remained undetected.

Examples of HIF will be shown using photos and videos to illustrate public and worker hazards and the risk of an arcing ignition source for fire.

Power Lines, High Impedance Faults, Electrocutation



D1 Pattern of Police Torture in Pakistan

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After attending this presentation, attendees will understand the originality of police torture in third world and developing countries.

This presentation will impact the forensic community and/or humanity by demonstrating the results of research work by forensic scientists from various developed and developing countries. It has been observed that there exist significant differences between countries regarding circumstances, torture methods, and sequel to torture. This knowledge is of value to forensic specialists documenting alleged torture and essential for fair and valid forensic statements.

Following the September 2001 terrorist attacks on the United States, much support for torture interrogation of terrorists has emerged in the public forum, largely based on the “ticking bomb” scenario. The counterargument, of course, is that in a society destroyed by terrorism there will be nothing to repair. That is why the actual causal mechanism of torture interrogation in curtailing terrorism must be elucidated rather than presumed.

A study of 1820 victims of alleged police torture was examined at the office of Surgeon Medico legal Punjab Lahore during a period of 5 years. Most of the victims at the time of examination were showing visible evidence of physical trauma. Victims were mainly males, ranging between the ages of 15 – 29 years (61%). The poor labor class form rural areas were shown more violence by police and agencies. Examination was conducted on the directions of various courts (Judicial Magistrates, District & Session Judges, and Lahore high court). A wide range of different types of injuries of different durations were observed on various parts of the body. Blunt trauma was most frequent and the most common weapon used was the big flat oil dipped slipper. Psychological element of torture was also seen in some victims. Sexual trauma to females and child abuse was observed in a number of cases; such harassment was a hallmark of Political victimization.

Police, Torture, Victim

D2 Suicide at the Work Place

Axelle Balgairies, Forensic Institute of Lille, France, Place Verdun, Lille, Nord Pas de Calais 59000, France; and Gilles Tournel, MD, Ann Becart-Robert, DDS, Valerie Hedouin, MD, and Didier Gosset, MD, PhD, Institut de Medecine Legale et de Medecine Sociale de Lille, Faculte de Medecine, 1, Place de Verdun, Lille, 59000, France*

The goal of this presentation is to focus on suicide at the workplace, to try to know any specificity about this kind of suicide, to understand the role of the job in the act of suicide, and to list if the suicide at the workplace was recognize as work injury.

This presentation will impact the forensic community and/or humanity by demonstrating the impact of the job in this kind of suicide and raising awareness about this problem of suicide at the workplace, and the recognition of work injury and the role of the job.

Introduction: In 2000, The French national institute of statistic (INSEE) recorded 10,832 deaths caused by suicide; it was 2% of the total death cases in France. Suicide is the number one cause of death within the young French people.

The so called “job related” suicide is very often difficult to establish because of determining which causes are truly work related. Regarding this topic, very few data are available and the literature is most likely referring to “death at the workplace.” Besides, this kind of suicide can be identified as work injury. In this case, the victim’s family can expect to receive compensation from the Social Security. The goal of this study was to list all the “workplace suicide” cases that occurred in the northern part of France and also to collect and analyze the data.

Materials and methods: It was a retrospective study based on the archives of the Lille institute of forensic medicine and forensic unities, but also on personal archives of the coroner of Lille and Dunkerque. Twenty-two cases were recorded from Jan 1, 1997 to Mar 31, 2005. Autopsy and scene reports were used in addition to the data. The following criteria were selected: Sex, age, time of death, professional background, autopsy or not, toxic ingestion, psychiatrics antecedent or previous suicide attempts (mode of suicide, personal or professional circumstances), explanatory document and the eventual work injury reports.

Regarding the professional background, the professional category (wordlist of INSEE), the company activity (CITI 2 V3 wordlist), and the victim’s job description (CITP 88 wordlist) were used. All reported work incident within the period were requested from the Social Security.

Results: Twenty-two files were selected (19 in Lille, 3 in Dunkerque, 1 in Douai).

All victims were men. Most of the victims were aged 40 to 50; the youngest and the oldest individuals being 25 and 58 respectively. Most of these suicides do not occur during regular working hours (9:00am – 6:00pm). These suicides are most likely to happen early in the morning or very late in the night. From a performance stand point, low qualified employees represent more than 50% of the recorded cases of samples. On an activity type stand point, most of the victims worked in the service or manufacturing industry. Ten out of 12 autopsied victims were qualified as clear suicide cases.

There is unfortunately a lot of missing data: Among 10 clearly identified suicide cases, it appeared that seven had psychiatric issues antecedent and that seven never attempted to end their life. Regarding any toxic ingestion history, 13 cases did not show any data, three were confirmed and six were negative. Mechanism of death was also listed in the data base: hanging seemed to be the most commonly used way to commit suicide.

Suicide causes clearly related to the job environment were rarely positively mentioned. At the opposite, personal issues were easier to identify: seven cases out of a selection of 13 clearly stated the personal issues factor as the suicide root cause.

Discussion: Despite the very few data available, this study allowed for a reflection on the job related suicide topic in the northern part of France. The lack of data can be explained by a very decentralized forensic organization (until the year 2000) in this part of the country. Moreover, suicide at the workplace remains a epiphenomena and the forensic department is not always involved in these very cases.

Clearly established suicide cases were selected in this study; attempts were ignored because of the lack of reliability of the data base. The absence of valid and available information is due to the fact that the coroner focuses most of the time on the investigation part of the suicide case to the prejudice of the autopsy. Nevertheless, it is possible to conclude on some epidemiological characteristics: 30 to 40 year old men seem to be the most affected group. Overall, men appear to be the majority of the suicide cases with a victim’s age average of 44.6.

As mentioned above, most of this kind of suicide do not occur during the regular working hours and are most of the time related to the

service and manufacturing industries. In addition, like mentioned in prior studies and reports, low qualified workers are predominant in the number of the so called work related suicides.

Unfortunately, the worker seniority could not be selected when psychiatric antecedents were commonly listed. Personal issues were often identified. It was not possible to really identify the professional environment and the personal background as root causes of the suicide.

Finally, it was noted that, as mentioned in most prior studies, that the most common way of suicide was hanging. A job related factor was identified through this study in some suicide cases. That's why a "job related" document was added in the forensic report.

Suicide, Work Accidents, Workplace

D3 Spontaneous Human Combustion (SHC): This Incomprehensible Phenomenon Refuses to Die

Alain Miras, MD, PhD, and Sophie Gromb, MD, PhD, Institute of Forensic Science, Groupe Pellegrin - Place Amelie Raba-Leon, Bordeaux, 33000, France*

After attending this presentation, attendees will learn of the existence of this curious phenomenon and the possibility of spontaneous release of fire under particular conditions.

This presentation will impact the forensic community and/or humanity by demonstrating not all fires obligatorily require a criminal, suspect or involuntary intervention of a human.

Several cases of human combustion, the cause of which was not evident, have been described over the last few centuries. These cases pose two kinds of enigmas. First, although the body is consumed, the immediate surroundings are left almost fully intact. Second, there is often no visible source of heat that might have started the fire. Furthermore, one is struck by the fact that the bodies are not completely consumed, certain parts being perfectly preserved, next to others that are reduced to a state of ashes.

Several hypotheses have been advanced over the years, the earliest of which seem ludicrous today. The authors review all these theories culminating with the most recent, scientific hypothesis based on experimental findings. They consist of alcohol, overage amount of fat and the "candle effect". Even though certain such deaths do not have fully satisfying explanations, medicolegal experts should be well aware of this phenomenon as it can have vital importance in cases that may involve homicide made to look like an accident or a suicide.

Spontaneous Human Combustion, Candle Effect, Fat

D4 Autopsy, Medical Examiner/Coroner System, and Decedent Characteristics: 1979-94 and 2003-04

Hsiang-Ching Kung, PhD, Donna L Hoyert, PhD, and Jiaquan Xu, MD, National Center for Health Statistics/CCHIS/CDC, MSB/DVS, Room 7318, 3311 Toledo Road, Hyattsville, MD 20782*

After attending this presentation, attendees will learn current autopsy performance prevalence, variance according to types of state medical examiner/coroner systems and decedent characteristics, and how patterns have changed over time.

This presentation will impact the forensic community and/or humanity by providing recent data on autopsy performance trends in the United States, a key indicator that has not been available since 1994. The elimination of the item in 1995 was criticized in a letter to the editor of JAMA (Hanzlick, National Autopsy Data Dropped, JAMA, vol. 280,

p. 886) as a problem for performance measurement, compliance, and national data analysis. The reinstatement of the item rectifies this.

Purpose: The purpose of this study was to examine 1) whether the percentage of deaths that were autopsied varied by medical examiner/coroner system, 2) whether the underlying cause of death among autopsied decedents varied by medical examiner/coroner system, 3) whether the characteristics of the decedents that were autopsied changed over time.

Methods: The study variables were drawn from death certificate data for the United States. Variables that were selected from the death certificate for the study were: if an autopsy was performed, age, race, sex, cause of death and the place of death. Percentages, ranking procedures, and statistical modeling were used to present the data and to describe the temporal trend.

Results: There was a decreasing trend for the performance of autopsy in the United States from 1979 to 2004. The percentage of deaths that were autopsied was higher in States with mixed medical examiner/coroner (me/c) systems than in States with coroner systems or medical examiner systems. The percentage of deaths that were autopsied was the highest for homicide (98.6%), SIDS (98.5%), and other external causes (79.5%) across all types of me/c systems. Being young, nonwhite, male, dying in the emergency room or dead on arrival also were associated with higher levels of being autopsied. Some of these characteristics reflect differences among subgroups in age and circumstances surrounding death.

Conclusion: Over the years, there is common ground in which deaths have an autopsy performed across types of me/c systems with homicide deaths most likely to be autopsied. Despite the value of autopsies, there is a decreasing trend in autopsy performance. The implication of the study results will be discussed.

Autopsy, Death Certificate, National Vital Statistics System

D5 Analysis of Patterns of Unnatural Deaths in Females Reported at Tertiary Care Hospital and Medical College in Eastern Nepal

Neha Malla, MBBS, Bishwanath Yadav, MD, and Chandra Bhal Tripathi, MD, B.P. Koirala Institute of Health Sciences, Department of Forensic Medicine, Dharan, Sunsari 56700, Nepal*

After attending this presentation, attendees will understand that violence against women is a universal reality. It is one of the important causes of morbidity and mortality in women. Violence against women has the greatest impact in South Asian countries, especially Nepal, where social and cultural norms seem to have accentuated the problem. It has major impact on the physical, social, and psychological health of women, leading to fatal outcomes like suicides and homicides. Though it's an important problem in society, little study has been conducted in this field.

This presentation will impact the forensic community and/or humanity by giving a glimpse of the existing problem of unnatural deaths in females in a developing country in South East Asia. The forensic community will have better knowledge of the problem, and can improve record keeping for assessment and better analysis of unnatural deaths in females. This would not only aid in justice, but would also help to mitigate the situation.

A retrospective study to assess the incidence and patterns on unnatural female deaths in 2062 B.S (April 2005-April 2006 A.D) was conducted at a tertiary care teaching hospital in Eastern Nepal. The study revealed that 87 cases of female unnatural deaths were reported out of 283 total autopsies conducted. The most common age group involved was 11-30 years of age (51.6%). Suicides were the most common cause of death (52.8%) followed by accidental deaths (40.22%)

then homicides (6.8%). Homicidal cases were likely to be under reported. Poisoning was the most common method of suicidal deaths (56.52%). More than half (52%) of women who committed suicide were married. Most suicide cases belonged to major hill, hill native and Terai middle and occupational group. Violence against women is one of the major problems of South Asian countries which can be decreased by promotion of women's issues awareness and education, for which proper data on female unnatural deaths is very essential.

Violence Against Women, Unnatural Deaths, Suicides

D6 Improved Weapons and Wound Patterns

Steven H. Brumm, MS, and Lorne L. Brooks*, Division of Public Safety Gulf Coast Community College, 5230 West Highway 98, Panama City, FL 32401*

After attending this presentation, attendees will understand how improvised weapons create unusual wound patterns.

This presentation will impact the forensic community and/or humanity by alerting investigators that unusual wound patterns may be caused by improvised weapons especially in a prison or jail setting.

Prison and jail populations, like all other societies today, are troubled by violent crimes. Inmates look to the correctional officers to protect them from violence but, as in cities today, the officers can't be everywhere at once and crime does occur. To protect themselves or to be able to carry out crimes of violence, inmates are very adept at improvising weapons from almost any material available to them. These weapons take many forms and tend to leave wound patterns that are different from those normally seen by investigating officers and Medical Examiners. The purpose of this presentation is to familiarize the attendee with some of the more common improvised weapons found in prisons and the wound patterns that they cause.

The one thing that inmates have is time. They have time to think of how to convert common things to weapons and they have hours to carry out their plans. An inmate who comes into possession of a suitable piece of plastic or metal thinks nothing of spending hours rubbing it against concrete to produce a sharp edge. Most weapons are defensive in nature. However, some are designed for offensive use and tend to be much stronger and often larger than defensive weapons. In general, once an inmate has made a weapon, he will conceal it in a public area so that if it is found by correctional officers, it can't be attributed to a specific inmate. However, some items can be concealed in plain view. For instance, a bar of soap in a sock makes a devastating impact weapon that can be instantly disassembled into two items the inmate is authorized to have. By the same token, a magazine rolled into a very tight cone can cause a fatal stab wound. Improvised weapons tend to fall into three major categories: impact, slicing, and stabbing. Each of these types of weapon produces a wound that is significantly different than the average knife or impact wound.

Over the years, the authors have collected a number of actual improvised weapons confiscated from inmates. There have been no modifications made to the weapons used in this presentation. The authors simply took the weapons and used them in their intended manner against a block of modeling clay. This produced patterns on and in the clay which would be very similar to wound patterns that might be observed by an investigating officer or medical examiner.

As expected, the weapons designed to slice or cut made impressions very much like a razor blade or box cutter. The impact weapons and the weapons designed to stab, however, produced impressions that were unique and unusual.

This presentation is designed to encourage investigators and medical examiners to think outside the box when they see an unusual wound pattern, particularly if the wound was produced in an area where there might be inmates or ex-inmates.

Improved Weapons, Wound Patterns, Prisons

D7 Drowned at Sea: Identification of a Sailor From the USS Gherardi Fifty-Two Years Later

Craig W. King, BS, William C. Rodriguez, PhD, Carna E. Meyer, MSFS, Demris Lee, MSFS, and Louis Finelli, DO, Armed Forces DNA ID Lab, 1413 Research Boulevard, Building 101, Rockville, MD 20850*

After attending this presentation, attendees will have a better understanding of the usefulness of modern forensic science methodologies in identifying historic remains. Attendees will bear witness to a tragic naval event through extensive historical photos and recent forensic findings which solved a fifty-two year old mystery.

This presentation will impact the forensic community and/or humanity by providing knowledge and resolution of a historic case utilizing two scientific disciplines.

On a stormy night just after midnight on December 2, 1942, two whaleboats were returning 34 sailors from liberty. One whaleboat successfully made the four mile journey back to the destroyer, USS Gherardi. The other would meet tragedy. In the middle of the storm that threatened the USS Gherardi herself, the second whaleboat was capsized by successive waves. Only two of the seventeen sailors survived the night amid the storm and icy waters of Narragansett Bay, Rhode Island. In the morning, five bodies that had washed ashore during the night were recovered along with the two survivors. Over the next several months, seven additional bodies were recovered and identified leaving only three men unaccounted for.

In August of 1943, fishermen recovered the partial remains of a body, which two naval medical officers determined was that of a naval enlisted man associated with the USS Gherardi loss. Positive identification could not be made at that time due to the decomposed and incomplete state of the body. The remains of the sailor were buried in an unmarked grave in Island Cemetery, Newport, Rhode Island, where they became forgotten over the next fifty-two years. In 1995 a retired Marine, Mr. Ted Darcy, was conducting an unrelated historical survey of Island Cemetery when he came across a gap in the grave plots. Mr. Darcy's continued investigation revealed that the unmarked grave plot contained the remains of an unknown sailor associated with the USS Gherardi tragedy. Over the next ten years Mr. Darcy obtained a memorial marker for the grave, and was able to locate direct relatives of the three unaccounted for sailors.

The information obtained by Mr. Darcy was forwarded to the U.S. Navy for verification. Upon verification, the Navy exhumed the remains in the spring of 2006 for the purpose of renewed identification efforts based on modern scientific analyses. Forensic anthropological examination of the remains by the Armed Forces Medical Examiner System (AFMES), revealed them to be most consistent with the biological profile reported for the youngest sailor in question, Seaman First Class Raymond S. Johnson. A section of bone was removed from one of the femurs and submitted to the Armed Forces DNA Identification Laboratory (AFDIL), for mitochondrial DNA testing.

Blood samples from the maternal relatives of the three unaccounted sailors were processed for the entire Control Region. The bone sample was organically extracted which yielded high quality results utilizing Primer Sets. The results of the skeletal sample showed concordance with the maternal relative of Seaman First Class Raymond S. Johnson within the targeted region with the exception of a heteroplasmic at position 152, while excluding the other two family references. As result of the DNA and forensic anthropological analyses, the remains were identified as Seaman First Class Raymond S. Johnson, putting to rest a fifty-two-year-old mystery.

Mitochondrial DNA Analysis, Historic Remains, Anthropology

D8 A Comparative Analysis of the Public Health Role of Death Investigation Systems

Stacy A. Drake, MSN, RN, Memorial Hermann Healthcare System, 6411 Fannin Street, Houston, TX 77030; Mary desVignes-Kendrick, MD, MPH, University of Texas Health Science Center School of Public Health, 1200 Herman Pressler, Houston, TX 77030; and Dwayne A. Wolf, MD, PhD, and Luis A. Sanchez, MD, Harris County Medical Examiner Office, 1885 Old Spanish Trail, Houston, TX 77054*

The goal of this presentation is to educate the forensic community about various public health roles played by death investigation systems in a diverse state practicing under a single medical examiner law in which death investigation is politically separate and distinct from state and local Public Health Departments.

This presentation will impact the forensic community and/or humanity by demonstrating preliminary results suggesting that the role of medical examiner/coroners in public health is more extensive than is widely recognized. Further, it appears that the instrument that has been developed to assess this role will be useful and applicable. Finally, mutual education of death investigators and public health officials of their respective roles will better serve the local community.

Public health is a broad term used to describe a system that takes an interdisciplinary approach to identify and prevent, promote and protect the safety of citizens within a community. Public health, similar to death investigation, is linked to governmental and political decision makers. The hypothesis underlying the current research is that death investigation is, in fact a public health function, regardless of the political alliance, or lack thereof, between the official entities. Conversely, public health departments rely heavily on data provided by medical examiner/coroners in order to assess, implement, and evaluate programs within communities. This reliance is widely recognized, although public health departments frequently do not understand the role of death investigators, and hence do not understand the limitations of the data thus derived. Regardless of political alliance, recognition of the mutually dependent roles and overlapping functions between these entities will serve the greater good of the community.

The ten essential roles of public health will be explored in depth throughout the presentation. In order to conduct this analysis, a standardized questionnaire addressing each of these roles was derived from the National Public Health Performance Standards, published by the federal Department of Health and Human Services. Specifically, questions were extracted from the Local Public Health System Performance Assessment Instrument component. Initial development and testing of this instrument involved face-to-face meetings with the local medical examiner (Harris County, Texas). Subsequently, questions were edited, revised, and amended to clarify their relevance to death investigation. Questionnaires were then mailed out to a representative sample of medical examiners and justices of the peace (equivalent to an elected coroner within this state) within Texas. Phone calls were implemented where necessary for clarification of specific points.

Initial findings were both expected and unexpected. It is widely known, for example that the local medical examiner (Harris County) plays an active role in child fatality reviews, disaster planning and in local trauma service morbidity/mortality conferences. The local medical examiner office also plays an active role in injury/violence prevention programs. An unexpected finding was that regulatory oversight of medical examiner offices and death investigation systems in this state are voluntary. Survey results will demonstrate a wide variability in the actual involvement in public health roles, and an even wider self-awareness of this involvement.

Our preliminary results suggest that the role of medical examiner/coroners in public health is more extensive than is widely recognized. Further, it appears that the instrument that has been

developed to assess this role will be useful and applicable. Mutual education of death investigators and public health officials of their respective roles will better serve the local community.

Death Investigation System, Public Health, Medical Examiner

D9 Utilizing Ultrasound Technology to Measure Facial Tissue Thickness in Canadian Aboriginal Populations

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After attending this presentation, attendees will have a better understanding of the data required for creating 3-D facial reconstructions; understand the need for utilizing facial tissue depths standards valid for a specific population of origin - presently, no data exist for facial tissue thickness in Canadian Aboriginal populations; and understand the methods employed for measuring tissue facial depth measurements.

This presentation will impact the forensic community and/or humanity by aiding in positive identifications for unknown skulls from peoples of indigenous ancestry.

1. This is ground breaking research and has never been published previously.
2. This new data can be utilized by law enforcement for creating more accurate pictures of what a missing child may look like today, years after they have disappeared.
3. This new data will aid in positive identifications for unknown skulls from peoples of indigenous ancestry.
4. This project will allow a new and positive connection to be made between Canadian First Nation communities and scientists.
5. As students will be trained to help use the ultrasound machine, this project will initiate proactive education and career-related training programs.

In forensic cases, when no identification is possible, facial reconstruction can aid in establishing an individual's identity. The purpose of this research is to add to the already existing databases of children and adults for use in 3-D facial reconstructions of unknown or missing individuals. When facial reconstruction is attempted, it is critical that the measurements utilized for facial tissue depths are standards valid for a specific population of origin.

Not all children grow at a similar rate and therefore it is difficult to establish methods that can be universally applied to predict the growth of children's faces. However, the most accurate growth prediction is likely to occur when large reference groups, similar to the population studied, are utilized to derive standard values. Since children of indigenous ethnicities are underrepresented in the published data for tissue depth thicknesses, this project provides additional methods for establishing the identity of unknown human child skeletons. This new data can also be utilized by the police department for creating pictures of what a missing child may look like today, years after they have disappeared.

Accurate measurements for facial tissue depth are an important and vital tool inside and outside of the medicolegal arena. In forensic contexts, this new data will aid in positive identifications for unknown skulls from peoples of indigenous ancestry. For the police, who are searching for a missing child, employing this new data may help a family reunite with their lost child. For traditional peoples, this new knowledge will give voice to a once forgotten group of peoples.

Forensic Anthropology, Facial Reconstruction, Indigenous Peoples

D10 A Further Attempt to Identify the Unidentified: The Resolve Initiative

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After attending this presentation, attendees will gain an understanding of the process for establishing a website to assist with identifying decedents where other methods have proven unsuccessful. The attendee will also gain an understanding of the value of using the internet for these difficult identification cases.

This presentation will impact the forensic community and/or humanity by increasing appreciation of how a website can assist with identifying bodies and remains where other methods have failed. The forensic community will also better understand how information can be provided on a public website in a sensitive and respectful manner.

The Office of the Chief Coroner (OCC) Ontario and the Ontario Provincial Police (OPP) unveiled a new website in May 2006 in an effort to help resolve cases of unidentified bodies/remains. This new website, accessed through www.opp.ca and entitled "THE RESOLVE INITIATIVE," contains information about both missing persons reported to the OPP (in which foul play cannot be ruled out), as well as unidentified bodies/remains cases, for the Province of Ontario (population 12 million).

Since 1975, there have been more than 150 cases in Ontario where, despite all efforts, the OCC has been unable to identify bodies or human remains. When more traditional methods have failed, some other jurisdictions have recently started to provide information on the internet, as one additional strategy to help identify these cases. The use of the internet has proven to be very effective, in large part due to the fact that the internet is widely used, available 24/7 and truly is "worldwide" – not limited to a province, state, country or even a continent.

Cases are included on the website when a decision has been made that other more traditional methods of identification have failed. Basic descriptive information is provided on all cases. Images are also presented when it has been determined that they may assist with identification. Where available, there are images of characteristic clothing, tattoos, or jewelry. In approximately 20% of cases, there are touched up photographs of the face taken at the time of autopsy. In ten cases of skeletal remains or badly decomposed bodies, there are artists' reconstructions, arising from cases where photographs are not helpful or inappropriate. In each and every case, significant efforts have been undertaken to ensure that the information and images are presented with sensitivity, out of respect for the deceased persons, their families and friends, and the public at large.

The goal of this new initiative is to provide the best information available on a public website, in as sensitive and respectful a manner as possible, to help identify persons when other methods have failed. During this presentation, four case scenarios will be highlighted from the website demonstrating the type of information that has been included. At the time of abstract submission, two cases have been identified as a direct result of this project.

Internet, Unidentified Bodies, Unidentified Remains

D11 The Final Round in Lane #14: Shooting Range Suicides

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The goal of this presentation is to report the findings encountered in a case series of suicides that occurred at indoor shooting ranges in Fairfax County, Virginia.

This presentation will impact the forensic community and/or humanity by providing information on the findings associated with suicides that occurred at indoor shooting ranges with emphasis on the relative ease of renting a firearm, location and characteristics of the wound, caliber of the handgun, items rented at the range, presence of a suicide note, and history of mental illness or life event.

Introduction: Suicide is one of the most important public health issues in the United States. Suicide represents the eleventh leading cause of death in the United States. Nearly 20% of the caseload of the Northern Virginia Office of the Chief Medical Examiner in Fairfax, Virginia is suicide. Suicide rates for this country have been relatively stable over the past decade with approximately 11 per 100,000 population. The most common method of suicide in the United States is the use of a firearm. However, to purchase a firearm in Virginia, one must be of legal age, successfully pass a criminal background check, and be a resident of Virginia for at least 30 days with two forms of identification.

Materials and Methods: This is a retrospective review of case files from the Northern Virginia Office of the Chief Medical Examiner in Fairfax, Virginia. Inclusionary data for this case series included cause of death being a gunshot wound, manner of death ruled as suicide, and place of injury being an indoor shooting range. These cases were reviewed for the following information: the location and characteristics of the gunshot wound, the caliber of weapon, the items rented at the range, the number of shots fired down range, underlying psychiatric illness or life event, the presence of alcohol or other commonly abused drugs, the presence of a suicide note and/or past ideations/attempts, and the demographics of the decedent. The case information was organized into a spread sheet and the data was analyzed for any trends or other interesting correlations.

Results: During the year 2005, 230 suicides were investigated by the Northern Virginia Office of the Chief Medical Examiner. Of these 230 suicides, 84 (37%) were caused by shooting oneself with a handgun. There were three cases of gunshot wound suicides involving a handgun with the place of injury being at a shooting range. The three decedents were male and each comprised a different ethnicity. Ethanol was present in the postmortem toxicology sample of one the decedents. Another decedent had both opiates and benzodiazepines in his postmortem toxicology sample. Only one individual left a suicide note. The location of the gunshot wound was intraoral (2) and right temple (1). Two decedents rented a 44 magnum revolver and the other used a recently purchased 9mm semiautomatic handgun which he was not allowed to possess but could shoot while at the range. Other items rented at the range included: ammunition, targets, eye, and ear protection. The two decedent's shot themselves with the first round. There was no known or documented history of depression, psychiatric illness, or life event in two of the decedents.

Conclusions: This case series emphasized the role that indoor shooting ranges with rental firearms play in suicides of person who otherwise are unable to own/purchase a handgun. In the year 2005, three individuals committed suicide by shooting themselves in the head with a rented handgun while at a shooting range. One individual was not allowed to own a handgun, another individual had all his firearms recently confiscated by law enforcement, and the third had his handgun purchase pending for a background check.

Suicide, Handgun, Shoot Range

D12 Are There Differences Between Cause of Death Among College Student and Death Among Non-College Students of the Same age Group?

Carrie Costello, BA, Purdue University/Tippecanoe County Coroner's Office, 205 South Intramural Drive, West Lafayette, IN 47907*

After attending this presentation, attendees will be briefed on the eleven year statistical overview and information gained in this research of deaths of Purdue University students versus deaths of the same aged individuals occurring in Tippecanoe County. This information can be utilized in analyzing the cause and manner of deaths with the focus on the possible on individual's deaths attending a higher level of education versus those individuals who have not attended a college or university.

This presentation will impact the forensic community and/or humanity by demonstrating the differences between the causes of death individuals who attend a university/college and those, of the same age range, whom do not. This information can be utilized to adjust, improve, and/or implement programs to assist in decreasing the preventable deaths.

From January 1995 through July 2006, there have been 122 deaths of Purdue University students; 25 committing suicide, 19 deaths due to natural causes; 54 deaths due to automobile accidents, and 17 deaths either accidental or undetermined. Whereas, the death, of individuals between the ages of 18-30 who do not have any college/ university or higher level of education, occurring in Tippecanoe County total 153. Of those deaths, 32 committed suicide; 15 were homicides; 70 were due to traffic accidents, 17 were ruled natural causes and 26 were ruled either accidental or undetermined.

The most astounding and unexpected difference was the cause of deaths due to drug overdoses. There were only 2 deaths due to accidental drug overdoses in the individuals who attended Purdue University, whereas there were 30 deaths due to accidental drug overdose in the individuals who died in Tippecanoe County, Indiana who did not attend Purdue University.

With a deeper understanding of the deaths among individuals between the ages of 18-30, risk behaviors may be identified as well as other findings that may assist in reducing the preventable deaths of both those who attend Purdue University and those who have no higher level of education in their background.

Death, College Students, Purdue University

D13 Role of the Forensic Clinical Nurse Specialist in Public Health, for Bioterrorism and Disaster Response Training of Nursing Staff

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The goal of this presentation is to illustrate how the forensic background and experience of the (Forensic Clinical Nurse Specialist) FCNS is ideally suited to this emerging position within public health; To describe public health core competencies for public health workers; and to describe the role of the FCNS in a large, urban health department.

This presentation will impact the forensic community and/or humanity by expanding the role and skill sets of Public Health Nurses, RNs, LVN/LPNs, and auxiliary nursing staff, within the communities already served; enhancing community and Public Health readiness to respond for a variety of emergencies or disasters; and improving

capacity for teamwork between Public Health nursing staff and other first responders in a given community, in accordance with federal and CDC standards.

Communities look to local public health departments for guidance and recommendations in a myriad of health-related situations on a daily basis. The potential and actualization of both natural and man-made disasters have prompted public health nursing to expand its role into new borders and frontiers to better serve target communities. The general role of public health in emergencies is an extension of the general mission of public health, i.e., to promote physical and mental health and prevent disease, injury, and disability (*Public Health in America*). This paper will focus on the training of Public Health Nursing and other health promotion or allied nursing staff.

Depending on the type of disaster or emergency, the role of an individual public health agency may be that of a lead position, collaborative, or supportive in nature. Therefore, public health staff must be competent to carry out a diverse range of responsibilities. Public health employees are designated as disaster service workers. The Centers for Disease Control (CDC) has defined core competencies for public health workers. Increasingly, job descriptions and functional roles define and reference emergency responsibilities and tasks. Examples of core responsibilities include disease surveillance and outbreak investigation and follow-up. These require multidisciplinary, multiagency collaboration on a regular basis; the need becomes more pivotal in biological, environmental, and/or weather emergencies. Man-made and natural disasters, emerging infectious diseases, e.g., SARS, and potential pandemics, e.g., avian flu, predicate a need for all Public Health Nurses to incorporate disaster planning and response into their repertoire of clinical skill sets.

Traditional public health work, such as tuberculosis, sexually transmitted diseases (STDs), other communicable diseases, maternal-child nursing, and high-risk infant follow up, to name but a few, continue to require the knowledge and experience of the Public Health Nurse (PHN). Increasing fiscal limitations and consolidation of programs and resources have presented challenges to both administrators and staff. The events of the last 5 years has brought to the forefront the need for public health nursing staff to incorporate an additional role into their arsenal of skills, that of disaster response. In addition to more typical emergency response, PHNs need to understand biological and chemical agents, basic principles of weapons of mass destruction, and the national incident command system (NIMS). All public health employees need to know chain-of-command, emergency response plans, their functional role in an emergency response, how to utilize communication equipment, and communication channels. Staff need to be able to identify limits and resources, recognize deviations from normal that might indicate an emergent situation, and how to take appropriate action.

Public health nursing professionals need to be able to demonstrate their clinical readiness to respond via regular exercises and drills. They should be able to incorporate epidemiological surveillance, laboratory resources, science-based investigations, and risk-assessment into their preparedness skills. Some of the disease entities that PHNs study for bioterrorism and disaster preparedness include smallpox, anthrax, plague, tularemia, and pandemic flu.

Specific clinical skills can be taught and demonstrated regularly, to ensure competency is maintained. Examples of these skills include the use of personal protective equipment (PPE), the incident command systems (ICS), phlebotomy skills, vaccination techniques (mass vaccination scenarios), nasopharyngeal swab collection, and methods to administer mass prophylaxis of antibiotics. Some counties, like Santa Clara County, California, are collaborating to operationalize the concept of influenza care centers (ICCs), as a modality of care in the event of pandemic flu. Likewise, points-of-distribution (PODs) are being planned for mass antibiotic distribution to a large population within a short interval of time, e.g., in a weaponized anthrax event. Public Health Nursing would have a pivotal role in all these non-traditional venues.

The forensic background of the FCNS is one that includes multidisciplinary teamwork and collaboration on a regular basis, with members of law enforcement, the criminal justice system, emergency departments, and other first responders. Forensic nurses are experts in the principles and practice of chain-of-custody. They are accustomed to troubleshooting gaps in knowledge and experience and at creative problem solving to achieve pragmatic solutions that can be tailored for an individual "fit." Likewise, the forensic experience crosses all geographical boundaries, i.e., urban, rural, state, regional, national, and global.

Forensic investigations parallel the process of disease surveillance. Most forensic nurses are versed at working in highly stressful clinical situations; thus they understand the implications of catastrophic events on both staff and vulnerable populations. The forensic clinical nurse specialist should be able to draw on forensic experiences to plan and implement training modules, exercises and drills, and to develop *just-in-time training* for exigent situations. Moreover, as a nurse, the FCNS can identify with, and better employ, creative solutions to the training of public health nursing personnel.

Disaster Nursing, Forensic Nurse, Public Health Nursing

D14 Forensic Nursing Science in Sweden

Jonas Lindgren, BSN, RN, National Board of Forensic Medicine in Sweden, PO-Box 408, Gothenburg, 405 30, Sweden*

After attending this presentation, attendees will be able to understand some of the development of forensic nursing death investigation and the forensic nurse's impact of the death investigation in Sweden. The attendees will be able to identify how the nursing science is applied in the area of forensic medicine in Sweden. This presentation will bring understanding and knowledge to the attendees about the movement and development of forensic nursing globally. The presentation will focus on the system of death investigation in Sweden and how the nurses have worked their way into the system during the five years that nurses have worked in the field and also how the discipline of forensic nursing science is developing in Sweden.

This presentation will impact the forensic community and/or humanity by providing understanding of the Development of Forensic Nursing Globally.

The Forensic Nurse Death Investigators impact on the medicolegal death investigation - Nurses have not been involved in medicolegal death investigations before the year 2000 in Sweden. There are five fulltime forensic nurse death investigators (FNDI) in Sweden in 2006.

In Sweden, there are approximately 5500 medicolegal death investigations conducted every year and the five FNDI are involved in 35% of the cases. The role of the FNDI in the medicolegal death investigation is the most prevalent connection with the next of kin during the whole process and investigating the medico-psycho-social aspects of the dead person.

The FNDI contributes to the medicolegal death investigation by conducting a psychosocial autopsy of cases in which the forensic pathologist is requiring more information to determine the manner of death. The psychosocial autopsy is based on facts that are revealed from talking to next of kin, reading hospital records, and following up every small detail about the dead person that could bring more information to the case.

The need for Forensic Nurse Death Investigators in the future - The national board of forensic medicine (NBFM) has requested an oversight of the system of death investigation from the Swedish government. In that request, the NBFM suggests that the FNDI would do a psychosocial autopsy of every case of sudden and unexpected death in Sweden. The FNDI then present the outcome of the psychosocial

autopsy to the forensic pathologist in charge. Based on this information, the forensic pathologist in charge will decide whether there are enough clinical background to determine the cause of death or a forensic autopsy should be done.

If the system will be changed in the way that the NBFM is suggesting then 20 more FNDI will have to be employed.

The development of forensic nursing science in Sweden - Jonas Lindgren is the first doctoral student in Sweden within the area of forensic nursing. In his dissertation, he is studying the community network surrounding the next of kin that has lost a loved one in sudden unexpected death and what impact the FNDI have on the next of kin.

In autumn 2006 or spring 2007, the first 5 credit course in forensic nursing in Scandinavia will be held at the University of Gothenburg.

The awareness of forensic nursing science among Swedish nurses is growing every year and that is mostly because the FNDI is involved in the training and education of nurses and other professionals in the area.

Forensic Nursing, Globally, Death investigation

D15 The Role of Testing for *Chlamydia Trachomatis* When Examining Sexually Abused Children

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After attending this presentation, attendees will understand the importance of testing for sexually transmitted diseases, in this case *Chlamydia trachomatis*, when examining sexually abused children, even in cases with normal ano-genital findings and no symptoms of sexually transmitted diseases.

This presentation will impact the forensic community and/or humanity by demonstrating the relevance of discussing the methods of documenting sexual abuse. The presence of a positive *Chlamydia trachomatis* culture in a pre-pubertal child is a strong indicator of abuse, and may be an important evidential factor. Researchers wished to evaluate the tests for *Chlamydia trachomatis* and point out the relevance and importance of performing cultures when looking for *Chlamydia trachomatis* infections in pre-pubertal children.

At the Institute of Forensic Medicine, Department of Forensic Pathology and Clinical Forensic Medicine, Aarhus University, Denmark, medicolegal examinations of suspected sexually abused and assaulted children have been performed since 1995. The children are referred to the Institute by the police, and in a few cases by the local pediatric department. The institute serves an area of approximately 2.5 million inhabitants, which is close to half of the Danish population.

The medicolegal examinations are performed by forensic pathologists specially trained in clinical forensic medicine and are undertaken to document signs of sexual abuse. The examination includes a colposcopic examination of the ano-genital area when possible, documented by digital video recording. When indicated by history, tests for sexually transmitted diseases are included in the examination. If treatment is needed, the children are referred to their local pediatric departments or their general practitioner.

All cases with examinations of allegedly sexually abused children at the Institute from January 1st 1995 to July 15th 2006 were evaluated. In total 618 children in the age group 0-14 years had been examined and in 93 % of cases, colposcopy was used as a diagnostic tool. Until 2006, there had been no positive test results of *Chlamydia trachomatis* or *Neisseria gonorrhoeae*. The first positive test result came back in a case of a single incestuous incident of sexual abuse by the step-father of an, at the time of the assault, eight year old girl, that took place approximately two and a half years prior to the time of examination.

Vaginal penetration was described by the girl. The colposcopic examination revealed normal ano-genital findings. A culture obtained from the vaginal wall came back positive for *Chlamydia trachomatis*.

The results of these tests so far may indicate a need for a discussion of the indications used for testing for sexually transmitted diseases in children and the methods used in the examinations. It's important to consider why the prevalence in the examined material is so low. Cultured tests for *Chlamydia trachomatis* have so far been the only reliable tests, when the results are meant to serve as possible forensic evidence, because it is highly specific, and positive PCR tests should be verified with a test culture. But it is also a test that adds to the discomfort of the examination, and may be impossible to obtain, therefore reliable alternative test methods would be advantageous to the examination. It is important to do continuing testing for sexually transmitted diseases, even though the incidence in this specific population is low. When the tests come back positive, they may serve as an important evidential factor.

Child Sexual Abuse, Sexually Transmitted Diseases, Chlamydia Trachomatis

D16 Investigative Case Management for Missing Children Homicides

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After attending this presentation, attendees will understand results from this study that will help police investigators to more timely and efficiently identify strategies and implement tactics that will lead to the capture of child abduction killers and the solutions of child abduction murder cases.

This presentation will impact the forensic community and/or humanity by demonstrating how very little information exists in social science literature about the victims of child abduction murder. This research will be used to improve the efficiency and effectiveness of the investigation processes of those murders.

The existing research on the rarity of child abduction murders, particularly those committed by non-family killers, shows clearly that most law enforcement jurisdictions in the United States will not be called on to investigate a child abduction murder. In fact, most homicide investigators will never investigate a child abduction murder over their entire career. However, it is prudent for investigators to be prepared. These investigations can put enormous strain on even the best prepared detectives, investigations, and jurisdictions. Their typically emotion-laden, volatile, high profile characteristics present unique challenges to law enforcement. This presentation will discuss the initial police involvement, the time frame within which an abducted child is killed and give an overview of the victims of child abduction murders.

Murder, Solvability, Child Abduction

D17 Nursing for a New Millennium — Forensic Nursing Course (NU 447): A Senior Nursing Baccalaureate Elective

Donna Garbacz-Bader, MSN, RN, and L. Sue Gabriel, RN, BSN, MFS*, BryanLGH College of Health Sciences, School of Nursing, 5035 Everett Street, Lincoln, NE 68506-1398*

After attending this presentation, attendees will be briefed on the tools necessary to develop an undergraduate forensic nursing course based on (2) credit hours of theory and (2) credit hours of comprehensive clinical activities.

This presentation will impact the forensic community and/or humanity by providing nurse and forensic science educators with a detailed curriculum format to develop an undergraduate Forensic Nursing Course with a full compliment of clinical experiences to correlate with nursing and forensic class theory and principles. The undergraduate forensic nursing course will provide the basic theory and principles of the forensic science process to that of the nursing process and allow for additional advanced forensic nursing training in forensic nursing graduate programs. This will provide the investigative team and the community with an additional knowledgeable and experienced member.

This course, the first complete (4) hour credit Forensic Nursing Course to be offered as a senior elective in a baccalaureate nursing program in the U.S., was developed as a result of increased awareness in the fields of forensic nursing and forensic science. This introductory course will concentrate on the application of forensic science theory to the nursing process with direct application to the provision of nursing care for the victim, family, society, and perpetrators of violent death and/or injury.

The course is based on forensic nursing as a subspecialty of nursing that includes the identification and treatment of victim injuries resulting from violence and trauma. It focuses on the role and responsibility of the forensic nurse with theory and concepts related to the:

1. Identification of injuries of abuse
2. Collection and preservation of medicolegal evidence
3. Initial treatment of injuries related to violence, abuse, and trauma
4. Death scene processing

Course examines the direct services provided by the forensic nurse to:

1. Individual clients
2. Consultation services to nursing, medical, law enforcement agencies
3. Court testimony in areas dealing with questioned death or violent trauma
4. Delivery of services and diagnoses of conditions as they relate to nursing

The presentation identifies the:

- Course Objectives
 - Course Placement
 - Prerequisite Courses
 - Credit Hours
 - Course Content
 - Teaching Strategies
 - Clinical Component
 - Professional Standards
-

Forensic Nursing, Forensic Nursing Undergraduate Nursing Course, Forensic Nursing Course Clinical Component

D18 Case Study: Insect Succession in Pig Carcasses in Two Regions of Japan Where U.S. Military is Present

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After attending this presentation, attendees will understand the use of entomology in determining of PMI and insect succession in two areas of Japan.

This presentation will impact the forensic community and/or humanity by helping to establish the succession of insects to remains in two different climates of Japan. The information collected will be used to help determine postmortem intervals and can be compared with similar climates in the United States.

A joint forensic entomology experiment was conducted to document insect succession in two regions of Japan where U.S. military troops are based. The experiment entailed documentation and sampling of adult and larval insects present on and around pig carcasses, and the rate of their development to assist in determination of postmortem interval. The results were then compared between the two U.S. military bases, approximately 40km apart: Yokosuka Naval Base and Yokota Air Base. This case study will provide U.S. law enforcement in Japan with information widely available in the United States on forensic entomology and estimates of postmortem interval, which is currently not available in Japan. Collection on the Yokosuka pig carcass (located in a humid, moist environment) produced three fly species, and at least six other insect species were collected in close proximity to the carcass. Collection on the Yokota pig carcass (located in a dry, arid climate) produced two fly species, and at least four other insect species were collected in close proximity to the carcass.

The pigs, both weighing approximately 95 pounds, were obtained from a local meat processing facility, and were transported to the research sites immediately after being sacrificed via blunt force trauma to the head. The carcasses were placed in metal mesh cages, enabling insects access to the carcasses, but preventing larger predators from consuming or tampering with the carcasses. Daily scene documentation, including humidity, soil temperature, and various body temperatures were collected from both pigs. Photographs and various samples, to include eggs, larva, adult, and soil, were collected daily from various places on and near the carcass. The Yokosuka pig was entirely covered by maggots by day #13 of the experiment and was fully desiccated and almost completely lacking in maggot activity on day #24. The experiment concluded after 39 days, when no insect activity was identified as present.

The Yokota pig exhibited more of the expected decomposition stages than the Yokosuka pig. The drier, more arid environment seemed to contribute to less immediate insect activity, and the pig carcass never reached the stage of full maggot coverage after 59 days, as seen on day #13 of the Yokosuka pig. The pig carcass experienced more normal stages of decomposition, vice complete consumption by insects, for the duration of the project which was ended after 60 days.

On the basis of these results, U.S. law enforcement in Japan should use caution in applying forensic entomology results from one region of Japan to another geographic region. The results indicate that even over short distances, the vast temperature and humidity disparities in Japan affect insect activity, decomposition, vegetation, and therefore,

consumption rates by carrion feeders. Based on this, more comprehensive research is necessary to conclusively identify trends and species in Japan's varying climates and regions. Due to international shipping restrictions prohibiting the shipment of live insects overseas, continued collaboration amongst U.S. law enforcement agencies in Japan is critical in cases involving forensic entomology evidence.

Insect, Postmortem Interval, Japan

D19 An Ancient Case of Spontaneous Human Combustion - Or Not!

Gareth W. Roberts, MSc, Bournemouth University, School of Conservation Sciences, Forensic Sciences Group, Room C140 Christchurch House, Fern Barrow, Poole, Dorset BH12 5BB, England*

After attending this presentation, attendees will gain a greater understanding for the need to carry out full and quantitative research supported by peer review and not allow those in authority to determine outcomes of a given case; and they will also learn that only the person making the examination, in full receipt of all the facts, can make a determination as to the origin and cause of a fatal fire.

This presentation will impact the forensic community and/or humanity by helping in the understanding of the importance of carrying out a thorough investigation and research into any given case regardless of what they are told by those in authority and that it is the Reporting Officer that will ultimately be responsible for the information contained in any report submitted to the Courts and not necessarily laboratory directors. Therefore, full, accurate, comprehensive, and unbiased reports are essential; and stimulating discussion between fire investigators and scientific staff on the subject of Spontaneous Human Combustion and does it actually exist as a scientific phenomenon?

This paper will discuss an ancient case of Spontaneous Human Combustion (SHC) occurring in rural England in 1613. In Southern England the Puritan faith had a grip on all aspects of local life. These priests preached repentance from sin, a Puritan faith, and compassion for other people. However, the obvious misery of so many people living in squalor and poverty seemed to be lost on them. During a particularly harsh period in the small town of Christchurch a fire occurred which resulted in the death of a local peasant. Despite witnesses to the incident, those in authority chose to listen to the local priest and as such, down through the ages the case was published in various articles as a case of Spontaneous Human Combustion. As the years passed the story became more embellished and accepted into local folklore. Extensive research has been carried out in relation to the incident and the structure in which the incident took place. Research has also explored how local superstitions can influence incidents of this nature. The reader will gain an understanding that not all published cases of "Spontaneous Human Combustion" are as they seem and that facts can be made to fit the case. This paper will discuss how ancient rights, superstitions and the views of those in power on the day have the ability to sway public opinion and change outcomes in order to suit their own needs. It will also demonstrate that simply constructed buildings of the day were no match for the natural elements. The conclusion of this case demonstrates that, with research, even the most simplistic of SHC cases can have an alternative ending and with due diligence and good research skills the writer can find better evidence to support a more scientific conclusion. Therefore, at the end of this presentation the reader has to be asked was this really a case of Spontaneous Human Combustion and does Spontaneous Human Combustion actually exist?

Fire, Ancient, SHC

D20 Cartridge Case Class Characteristics of Rotating Multi-Barrel Firearm: The Gatling Gun

Douglas D. Scott, PhD*, Nebraska Wesleyan University, 11101 South 98th Street, Lincoln, NE 68526

After attending this presentation, attendees will appreciate the fact that historic firearms have definable class characteristics. The class and individual characteristics are preserved on cartridge cases and bullets that can be very old, and non-judicial situations provide firearm identification theory and methods validation opportunities.

Firearm identification procedures are well established and used routinely in medic-legal situations. This presentation will impact the forensic community and/or humanity by demonstrating how studies of historic firearms can be used as additional validation opportunities of firearm identification theory and methods. In addition, class characteristic data from historic firearms provides archaeologists and others studying historic battlefields more data sets to enhance their interpretation opportunities of past conflict.

The Gatling gun is one of mid-19th century's most iconic firearms. Sold world-wide it saw action in many places around the globe in the late 1800s. Examination of several Gatling guns has identified a series of class characteristics that are transferred to cartridge cases and bullets during firing. While the Gatling gun is unlikely to be used in crime today, determining the class characteristics for this historic weapon is an interesting validation exercise in pattern transfer theory, and a valuable data set for battlefield archaeology use where Gatling guns were employed. Thirty-nine fired .50-70-caliber cartridge cases, one misfired round, and six .50-caliber bullets were submitted for analysis from an 1874 Red River War battlefield where Cheyenne warriors attempted to protect their families from an Army attack led by General Nelson A. Miles. This west Texas site represents the first recorded use of a Gatling gun in combat in the United States since the Civil War. The Gatling gun was used in combat by the U.S. Army only twice more before the Spanish-Cuban-American War of 1898. The .50-70 caliber bullets and cartridge cases submitted for firearms identifications analysis from 41AM10 were fired in a Gatling gun. The land and groove striations on the bullets, and the firing pin and extractor marks on the fired cartridge cases are consistent with barrel rifling, firing pins, and extractor characteristics found on surviving Gatling guns. This firearms identification analysis is the first time Gatling guns have been identified in an archeological context.

Historic, Firearms, Class Characteristics

D21 Virtual Autopsy of a Natural Mummified Fetus: About One Case

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The goal of this presentation is to illustrate the potentialities of the multi-slice computed tomography (MSCT) for the study of a natural

fetal mummy in term of skeletal evaluation (to research abnormalities), but also in term of gestational age assessment using methods not directly accessible during autopsy.

This presentation will impact the forensic community and/or humanity by providing an example of forensic application of the MSCT.

Background: Multi-slice computed tomography (MSCT) is uncommonly used in forensic pathology. The authors present a case of MSCT examination of a natural mummified fetus. This exploration was performed in order to determine gestational age and make an exhaustive skeletal study of the fetus.

Purpose: This case report illustrates the potentialities of the MSCT concerning one natural fetal mummy in terms of skeletal evaluation to research abnormalities, but also in term of gestational age assessment using methods not directly accessible during autopsy.

Introduction: A jar containing the body of a fetus was found in a bush near a building. The body was mummified. The body was unidentified. A medico legal autopsy was ordered. Multi-slice computed tomographies (MSCT) examination of the fetus was performed in order to determinate gestational age and make an exhaustive skeletal study of the fetus. It was followed by an autopsy and an anatomo-pathological study to evaluate gestational age and detect potential malformations. Results of the different studies were finally compared.

Material and Methods: *Imaging study:* a full body MSCT exploration was performed with a 16 x 0.75 mm collimation on a Sensation 16 unit (Siemens, Germany). Based on results of obstetrical osteometrical criteria by measurement of different parts of the fetus, an assessment of the gestational age was made. Age estimation based on temporal bones analysis was also performed. Two- (2D) and three dimensional (3D) reconstructions were obtained on a Leonardo workstation (Siemens, Germany). Images interpretations were performed by board-certified radiologists.

Autoptical and anatomo-pathologic studies were performed by board-certified forensic pathologists. All three body cavities (cranium, thorax, and abdomen) were examined. The lengths of the tibia and the foot were measured. Anatomo-pathology was performed after a fixation in 10% formalin and decalcification with nitric acid.

Results: *MSCT imaging:* the MSCT exploration found no traumatic bone fractures. Air between the skull and the cerebral hemispheres and the prominence of the ventricles were clearly visualized; both were caused by volume loss. The cerebral hemispheres, cerebellum, pons, medulla oblongata, and the spinal cord could also be seen. In the thorax, the lungs appeared tiny, non-aerated. The trachea and both major bronchi were visible, with lumen air-filled. The esophagus was visible from its proximal to distal extremity, filled with air. The heart was seen, but characterization of the four cardiac chambers was not possible. The liver was visible. The stomach contained air. Other internal organs were not identifiable because of an insufficient spontaneous contrast. The length of tibias was 40 millimeters, what corresponds to a gestational age of 23 weeks. Concerning external ear, both external auditory canals were well defined, normally aerated. Concerning middle ear, the malleus, stapes, and incus were present with a non-disrupted ossicular chain. The footplate of the stapes is visualized within the oval window. Concerning internal ear, MSCT scan shows that cochlea and vestibule had reached full adult size. The lateral, posterior, and superior semicircular canals were visible. The labyrinthine segment of the facial nerve canal was well developed. Internal auditory canal was also well defined. Both vestibular aqueducts were visible but not cochlear aqueducts. The labyrinthine segment of the facial canal and the pyramidal process were well defined. All this image's findings were in favor of a gestational age ranged between 22 and 24 weeks.

Autopsy and anatomo-pathology: the body was a male fetus completely mummified. The distal extremity of the navel string was present but the placenta was absent. The fetus was curled oneself up. No malformation was noted. The examination of the body revealed no evidence of trauma. The autopsy was difficult because of the dried

consistence of the corpse. It was very fragile and it was not possible to free the anterior part of the body without breaking the upper and lower members. The length of tibias was 40 millimeters, which corresponds to a gestational age of 23 weeks. The length of the foot was 35 millimeters, which represents an estimated gestational age ranging from 21 and 22 weeks. The tibia presented an endochondral ossification. The periosteum was ossified. The striated muscle comported well defined striations. The skin had a keratinised epidermis. Dermal papilla and sebaceous glands and papilla of hair were visible. An endochondral ossification was noted in the temporal bone. Ossicular chain was visible, surrounded by mesenchyma. The facial nerve was also visible. The three semicircular canals were present. Ossification had started in the cochlea. Histological analysis confirms that the fetal growth (osseous, vestibulocochlear, cutaneomuscular) was at least 20 weeks.

Discussion: Gestational age is determined by estimation of the fetus's development age concluded from the skeletal growth. With the development of prenatal ultrasonography, several abacuses became available for complete fetuses or ossified parts of developing bones. In forensic practice, abacuses can be useful in real anatomical conditions; however, radiographic methodology has to be applied when skeletal preparation is impossible or undesirable. MSCT give an isotropic image, with no deformation of the anatomical reality. This is important because measuring lengths of long bones on 2D reconstructions gives directly the anatomical length, without using corrective factors. In cases of particular position, as in this case, radiographic evaluation of the long bones' lengths with plain X-Rays seems to be difficult or impossible because of the superposition of the bones caused by the particular position of the body. MSCT permits with one single scanning to determine all or most of the long bones' lengths. Furthermore, it allows a skeletal and visceral exploration to determine if major abnormalities are present or not. A supplementary element to assess gestational age was used in this case: the analysis of the structures of the temporal bones. Although this exploration is not accessible to autopsy, study of the temporal bone is important for detection of congenital disorders and may bring elements to assess the gestational age. Furthermore, autopsy of mummified corpses is technically difficult because of the leak of elasticity of the different parts of the body, which break easily. Measures of long bones performed on MSCT images and on histological samples were identical and consequently gestational age assessment too. Study of temporal bones on MSCT images and histological samples were precise. Of course, accurate dating through histogenesis is imprecise because of the maternofetal factors which may interfere with the fetal development (drug addiction, metabolic disorders). However, it may give elements for estimate the range of gestational weeks.

Conclusion: MSCT is a non-destructive method available for mummy investigation. This case report illustrates the potentialities of the MSCT concerning one natural fetal mummy in term of skeletal evaluation to research abnormalities, but also in term of gestational age assessment using methods not accessible to autopsy.

Computed Tomography, Mummy, Fetus

D22 The Microscopic Characteristics of Drying and Transfer of Impacted Bloodstains on Fabric and Textiles

Marilyn T Miller, MS, EdD, Elizabeth DiMarchi, and Lei Zhang, BS, Virginia Commonwealth University, Box 842012, 1000 West Cary Street, Richmond, VA 23284-2012*

After attending this presentation, attendees will understand the microscopic appearance of drying and dried impacted bloodstains as part of a bloodstain pattern analysis.

This presentation will impact the forensic community and/or humanity by allowing for more precise determinations of time for bloodshed events where impacted bloodstain patterns are present.

Blood shed events and the resulting bloodstain patterns have been used for the purposes of crime scene reconstruction for many years. It is widely accepted in courtrooms, crime scene investigations, and taught extensively to criminal justice and forensic science students throughout the United States. Although bloodstain pattern analysis is widely accepted and widely taught, this project's testing in the area of microscopic analysis of bloodstain transfer mechanisms on drying has not been researched.

This project extensively analyzed and documented the semi-microscopic drying mechanism of medium force impact blood spatter on selected natural and synthetic fabrics. Additionally, the photo-documentation of the semi-microscopic mechanisms by which blood could be transferred between fabrics was examined.

The results of the drying tests show that the impacted bloodstains immediately become incorporated into the matrix of the fabric and not as predicted, the stains do not remain on the surface of the fabrics while drying. The quick drying of these impacted bloodstains within the fabric matrices also seems to make transfer by contact difficult even with added force.

Bloodstain Patterns, Impacted Blood, Microscopic Drying

D23 Suicides in Tarrant County Medical Examiners District Between 1996-2005: A Ten Year study

Nannepaga Zachariah, PhD, and Nizam Peerwani, MD, Tarrant County Medical Examiners Office, 200 Feliks Gwozdz Place, Ft. Worth, TX 76104*

After attending this presentation, attendees will understand the role of the Medical Examiners office, to assist the community to understand the distribution of suicides in Tarrant County according to the age, race, and sex.

This presentation will impact the forensic community and/or humanity by providing knowledge of suicidal trends during the last ten years, as related to sex, race and different age groups; and comparing suicidal rates to the geographic location of Tarrant County establishing a possible impact on economic status.

The Tarrant County Medical Examiner's Office serves a tri county population of over 2.2 million that includes Tarrant, Denton, and Parker counties. Approximately 200 suicide cases of all age groups, races, and cause of suicide are recorded annually. The following table gives the suicide data between the years 1996 and 2005 including suicide rates per 100,000 population.

Table1 Distribution between 1996-2005

GENDER	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	TOTAL
MALE	155	155	133	136	141	124	134	169	147	200	1494
FEMALE	36	36	34	29	29	51	50	44	60	48	417
TOTAL	191	191	167	165	170	175	184	213	207	248	1911
% of TOTAL	9.9	9.9	8.7	8.6	8.8	9.1	9.6	11.1	10.8	12.9	100%
RATE/PER 100,000 POPULATION	11.2	10.9	9.2	8.8	8.6	8.7	8.8	9.8	9.3	10.7	

Table 2 Distribution among Race

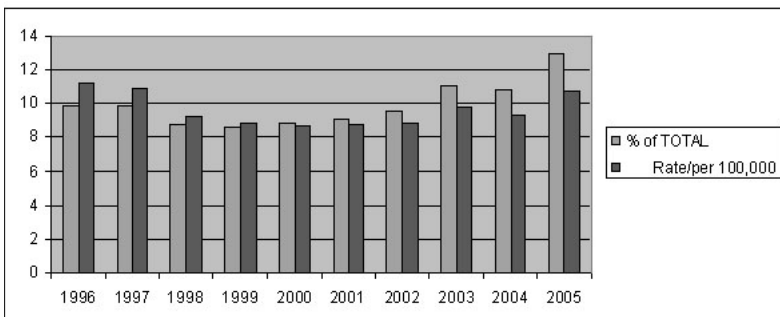
RACE	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	TOTAL
WHITE	160	168	143	136	145	125	126	179	175	214	1571
BLACK	11	7	7	7	11	10	28	13	14	16	118
HISPANIC	17	13	13	20	12	36	22	15	13	14	183
OTHER	3	3	4	2	2	4	8	6	5	4	41
TOTALS	191	191	167	165	170	175	184	213	207	248	1911

Table 3 Distribution among Age Groups

AGE	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	TOTAL
00--10	1	0	0	0	0	0	0	0	0	0	1
11--20	24	23	21	14	21	13	10	20	24	18	188
21--30	36	28	34	33	32	22	26	32	37	50	330
31--40	41	42	35	34	39	40	48	45	37	42	403
41--50	42	47	26	36	29	47	38	55	47	56	423
51--60	23	18	21	20	19	30	29	37	40	42	279
61--70	11	14	16	9	10	7	10	15	14	17	123
71--80	11	10	12	14	8	12	17	6	5	11	106
OVER 80	2	9	1	4	8	4	6	3	3	10	50
UKN	0	0	1	1	4	0	0	0	0	3	8
TOTAL	191	191	167	165	170	175	184	213	207	249	1911

Table 4 Cause of Suicide

CAUSE	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	TOTAL
DRUGS/POISONS	20	14	13	16	8	20	26	27	26	26	196
FIREARMS	107	123	109	110	95	116	97	115	116	148	1136
HANGING	35	27	27	23	41	27	41	43	43	43	350
OTHER	29	27	18	16	26	12	20	28	22	32	229
TOTAL	191	191	167	165	170	175	184	213	207	249	1911



1. Over the ten year period there seems to be a declining trend in suicide rates from 1996 to 2000. Somewhat of an increasing trend in suicide rate is indicated during recent years. See Graph.

2. Collected data over the last 10 yrs indicate suicide rates are much higher in males (78.1%) than in females (27.9%).

3. Predominantly higher rates are observed in white population (82.2%) followed by hispanic (9.4%) and black population (6.15%).

4. Among all the methods studied, death was predominantly caused by a firearm throughout the 10 year period (59.4%) followed by Hanging 18.3%, Drugs and Poisons 10.2%. The remaining 22.9% included other causes such as asphyxia, fire, CO, drowning, blunt force and sharp force trauma, and vehicular related.

Tarrant County, Suicide, Suicidal Rate

D24 An Unusual Death by Suffocation With a Plastic Bag: How a Motion Picture Can Help to Make the Distinction Between Homicide and Suicide

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After attending this presentation, attendees will understand the circumstances of an unusual suicide. The suicide is discussed to reduce the potential for mistakes in such cases in which it may be difficult to establish whether suicide or homicide occurred.

This presentation will impact the forensic community and/or humanity by demonstrating that manner and cause of death could be determined only by a thorough analysis of the physical and circumstantial evidence available to the medicolegal team.

Introduction: Asphyxia by smothering involves the mechanical obstruction of mouth and nose. Asphyxial deaths due to plastic bags may result from accidents, suicides, or homicides, although suicides seem to predominate.

Case report: A 32-year old married truck driver was found dead by the police lying in the fetal position in his truck on a desert street. The head was enclosed in a large clear plastic bag with its open end fixed to the neck with a rope. The wrists were firmly tied by a rope and the man was fully dressed in his usual daytime clothes. The doors were locked from the inside. There was no evidence of violence, and neither pornographic material nor autoerotic paraphernalia was found. A DVD was found in the glove compartment ("The life of David Gale", a 2003 motion picture directed by Alan Parker). A remarkable cyanosis of the face and lips, and subconjunctival petechial hemorrhages were noted. A medicolegal autopsy was ordered by the public prosecutor's department. The external examination was unremarkable. The autopsy showed thin hemorrhages in the subcutaneous tissues of the neck and in the lower rectal mucosa. The lungs were congested. No fracture of the hyoid bone or the thyroid cartilage was noted. Swollen glands were located around both sternocleidomastoid muscles. There was no lesion of fight or self defense on the body. The toxicological analysis was negative. The histologic examination of the rectal mucosa showed aspecific abnormalities. A diagnosis of death due to plastic bag asphyxia was made. This was initially treated by the police as homicidal case. The legal inquiry revealed that the man was not known to have attempted suicide before. He had homosexual relationships and had been diagnosed HIV positive two days prior to his death. "The life of David Gale" was seen by the police. In this movie the main character is found lying on her kitchen floor naked, hand-cuffed with a plastic bag over her head. The ending reveals she has committed suicide. Data eventually led to the conclusion that this case had actually been a suicide.

Discussion: In this case, the man had obviously committed suicide using the method he had seen in the movie. He had just learned he suffered from HIV and this should have led him to the revelation of his double life to his wife. Medicolegal data alone would not have determined whether homicide or suicide had occurred in this case. It is very infrequent in France to establish the manner of death thanks to seeing a motion picture.

Asphyxia, Suffocation, Plastic Bag

D25 The Study and Forensic Significance of Drill Bit Use Indicators

Gui-Hua L. Lang, PhD, and Gregory S. Klees, BA, Bureau of Alcohol, Tobacco, Firearms and Explosives, 6000 Ammendale Road, Ammendale, MD 20705*

After attending this presentation, attendees will learn how to identify a used drill bit and the forensic significance of tool marks on swarf (shavings and particles) produced during a drilling process.

This presentation will impact the forensic community by showing that a drill bit could be an important piece of information to close a bombing case and broadening Forensic Scientists' knowledge spectrum.

Every piece of the forensic evidence has the potential of supplying a valuable investigative lead, and even the tiniest pieces are examined thoroughly to assist the investigators in solving bombing cases. Drill bits are one piece of evidence that is often overlooked during a case investigation. Most domestic bombs in the United States are pipe bombs using metal or plastic containers filled with low explosive powders. Black steel and galvanized steel pipe with iron end caps are the most common metal containers among metal pipe bombs. Polyvinyl chloride (PVC) and chlorinated PVC (CPVC) are the most common plastic pipe bomb containers used in device making. The majority of these pipe devices are manufactured to be initiated with a length of pyrotechnic fuse through a fuse hole. A functional fuse would initiate the explosives inside these pipe devices. Since electric drills (cord or cordless types) are common household tools, most of the fuse holes are made by using these types of drill with a drill bit. The drill bit used for drilling the fuse holes can provide important forensic values to case investigations. For example, linking a drill bit to a device could directly link a suspect to a particular scene or device. However, no study has been done in the area of drill bits. In this study, the forensic and evidentiary values of a drill bit was investigated. With the results of this study, investigators were able to conclude that there are three indicators for determining if a drill bit is used. If a drill bit is used, one of these three indicators or the combination of all three indicators should be used as a guideline for evaluation. The three indicators are: 1). particulate deposits on the drill bit, especially inside the flute and the tip area; 2). physical damage including chipping, abrasion, and abuses on the drill bit mostly occurred on the flute edge bevels and lip edges; and 3). thermal damage. During this study, the forensic values of tool marks of drill bits were also evaluated. The study concluded that there is no mechanical break-in process like firearms barrel for obtaining reproducible tool marks. The tool marks on swarf were well defined and can be examined and individually associated.

Drill Bit, Tool Marks, Shavings

D26 Digital Evidence Practitioner Standards: Issues and Possible Solutions

Marcus K. Rogers, PhD, Purdue, 401 North Grant Street, West Lafayette, IN 47907*

After attending this presentation, attendees will have a better understanding of the challenges facing current efforts aimed at standardizing the digital evidence process and practice.

This presentation will impact the forensic community and/or humanity by demonstrating how the successful and timely development of standards is the key requirement in order to mature the relatively new forensic discipline of digital forensics.

The current presentation will examine issues related to developing standards for digital evidence practitioners. An overview of current efforts will be presented. Representative efforts from law enforcement, private sector, government, and academia will be compared and contrasted. A framework for successfully developing standards,

domains of knowledge, and a common body of knowledge will also be presented. With the rapid increase in digital evidence, the development of national and international standards is paramount in order to mature the discipline of digital forensics in general and digital evidence specifically.

Digital Evidence, Digital Forensics, Computer Forensics

D27 Color Perception and the Description of Evidence

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After attending this presentation, attendees will understand the correct use of the ISCC-NBS Dictionary of Color to describe the color of an item of evidence. This practice is tested by observers who need to define their own color description versus choosing one from a list of standardized color terms.

This presentation will impact the forensic community and/or humanity by introducing methods of standardized color description and the underlying reasons. The use of standardized color will diminish the potential misperception of a color description in the courtroom.

Color perception is an area which has been studied vastly in the past. It is an area which still needs development since color is a basic characteristic which is cited in physical evidence. Matching of color takes place in paint and fiber examinations on a micro-scale and color is frequently used on a macro-scale by forensic scientists and crime scene technicians in the description of evidence.

Forensic scientists should make use of a limited palette when describing the color of an item of evidence. Color may be attributed to an object in both subjective and objective manners. The determination of Munsell or CIE Lab color coordinates does not mean much to the layperson or even a forensic scientist who does not have experience with color theory.

A number of subjects were tested by evaluating a palette of colors and assigning a color to each swatch in the palette. In the control study the same group was asked to link a list of colors from the ISCC-NBS Dictionary of Color to a different palette of colors. It was hypothesized that the accuracy of the two groups can be differentiated from each other where individuals are far better at linking a color to a given color swatch than being able to define the color for themselves.

The research aimed at evaluating the observers' definition of a color name such as turquoise. It has been described as bluish-green, light bluish-green, bright bluish-green, medium bluish-green and medium greenish-blue. This has indicated that amongst users there is no standard nomenclature of describing a color. When asked to link an ISCC-NBS color to a Munsell color chip (5PB 7/4, pale blue) the observers were provided with a list of colors namely, light blue, light bluish gray, moderate blue, grayish blue, bluish gray, pale blue, and very pale blue. Although none of the observers identified the color as pale blue, all of the selected colors were of the same or a little lower chroma. The Munsell colors are related to the fourth level of the six levels of the Universal Color Language. In the fourth level the steps of the hue and value components of a Munsell color are limited to one unit. The fourth level consists of 943 to 7056 colors. The colors used by the ISCC-NBS color naming system comprises of 267 color names (third level). Pale Blue, for example, extends over a chroma range of 4.5 units and the value over a range of two units. The first and second levels comprise of 13 and 29 colors respectively.

The provision of a juror of a more accurate description of a color will allow them in their own minds to make a color definition. Use of a standardized color nomenclature system in forensic science will also

result in better testimony and minimized question regarding evidence description. Moving from the first level through the third level introduces more variations. Simply utilizing the fourth level would be too technical for a jury as is applied to casework analysis. This paper will provide support for the explicit use of at least the second level as descriptive colors in forensic casework.

Color, Perception, standardization

D28 Biometric Devices and Software for Facial Comparison and Iris Matching: Use in Forensic Science?

Zeno J. Geradts, PhD, Arnout Ruifrok, PhD, and Rikkert Zoun, MS, Netherlands Forensic Institute, Laan van Ypenburg 6, Den Haag, SH 2497GB, Netherlands*

After attending this presentation, attendees will understand how the various aspects of biometric devices and the use of biometric software for face and iris comparison will impact casework.

This presentation will impact the forensic community and/or humanity by demonstrating the challenges in using these systems in investigations, and the information that can be extracted as evidence from digital traces in these systems.

The use of biometric properties in access control is growing. Nowadays these devices used for access to computers, sport clubs and of course the borders. The ICAO-standards for implementation in a biometric passport are an example of this. In these ICAO-standards, the specifications are given of the contactless chip and of the resolution of the images. As the storage in these chips is limited, the quality, due to the resolution and compression of facial images is not enough for a proper forensic face comparison.

Many implementations of biometric devices and software are available in commercial products, such as use of facial comparison, iris, finger prints, hand scanner, vein scanner etc.

With the use of biometric systems, the possibility to enter the biometric features in databases also exists. In this way, a person can be identified from the database. An overview will be given in this presentation of the biometric properties of such a system, such as false acceptance rate, false reject rate, failure to enroll rate.

For forensic science, it is important to know how the systems can be circumvented, since the digital traces from these devices might be used as evidence in court.

In theory, it would be easier to follow a person, and check if the person is actually there. However, a problem is that with the wide use of biometric systems, it becomes easier to spoof a fingerprint, or another biometric feature. Examples of spoofing biometrics are well known, and some of them can be easy.

For evaluation of biometric systems in forensic science, it might be useful to have databases of faces and irises, such as is also implemented in the widely used AFIS-systems. In Netherlands Forensic Institute laboratory, a widely used facial biometric system and an iris system were analyzed. The results of this research, with different properties of the systems, are presented.

Another field of research is the linkage of biometric properties. In practice, it appeared that on several commercial devices no encryption was used, which make it easier to sniff biometric properties such as fingerprints from the USB-connection.

To date, there have only been a few cases requiring analysis of biometric devices. One case was a PDA with fingerprint access control. To enter the system, a rubber stamp was manufactured from a slip of the suspect. It is expected that there will be more cases with biometric devices in the future. Current research focuses on the value of image databases for facial comparison.

Biometric Devices, Iris Matching, Facial Comparison

D29 Forensic Voice Line-Ups: Intentional vs. Incidental Memory

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After attending this presentation, attendees will learn to improve their methodology when administering voice line-ups.

This presentation will impact the forensic community and/or humanity by demonstrating how to improve methodology when carrying out voice line-ups. It will help the expert and the courts to better assess the performance of ear witnesses.

While forensic voice comparisons are normally carried out by the forensic phonetician based on speech samples recorded during the incident (questioned sample) on the one hand and reference material from the suspect on the other, there are also cases in which no questioned recording is available, and yet one or more witnesses or victims claim that they will recognize the perpetrator's voice. The basic question asked in this contribution is thus whether witnesses who (claim to) have intentionally memorized the perpetrator's voice can be expected to exhibit a more reliable performance in a voice line-up as compared to witnesses who simply panicked as a reaction to the incident and memorized a somewhat holistic impression of the perpetrator's voice.

The research questions in the present study were as follows:

- Will intentional vs. incidental memory induce a difference in listener performance?
- Will time delay have an effect on listener performance?

A total of four listener groups consisting of 8 (in one instance 9) subjects each participated in the experiment. They were familiarized with the target voice in two separate sessions over high-quality loudspeakers in a quiet room for 12 min. The first group (16 subjects) were expressly instructed to memorize the target voice and they were told that they would later be asked to take part in a speaker recognition experiment. The second group (17 subjects) was instructed to memorize the wording of the message. Thus, their attention was expressly directed to the content of the message and away from the characteristics of the speaker.

Of those two subgroups consisting of 16/17 subjects, eight (in one instance nine) took part in a recognition task after one week and the other eight performed an identification experiment after a four-week delay. All four groups were presented with the same stimulus tape in the recognition experiment. It consisted of single sentences from the "kidnapper's" message that had also been used in the familiarization session. For the target speaker, the text was identical, but the actual sentences were taken from later recordings of the same text (the time span from which the test items dated was approximately 6 months). So in contrast to other studies like e.g., Schiller/Köster (1998) the listeners heard the same wording as in the familiarization, but not the identical passage. In addition to the target speaker, four foils were selected from the above-mentioned data base. They all exhibited the same regional background and age group as the target speaker. For each of the foils, a total of 20 sentences were selected, which results in a grand total of 100 stimulus sentences.

Subjects were instructed to listen carefully to the stimuli and to tick "yes" if they thought that this was the speaker whom they had heard in the familiarization session and to mark their confidence on a five-point scale. They were also reminded of the possibility that the target speaker might not be among the speakers in the recognition session at all. They were not informed about the total number of voices present in the test.

Two groups of listeners performed the recognition task one week after the familiarization session, the two other groups carried it out four weeks after having been familiarized with the voice.

A traditionally well-accepted measure of listener performance is the receiver operating characteristic (ROC) which plots the hit rate against the false alarm rate.

The results of the present study demonstrate that after one week there is practically no difference in recognition rates between listener groups who presumably used intentional as opposed to incidental memory. However, after 4 weeks, recognition rates generated by intentional memory statistically surpassed those generated by incidental memory. Also, incidental memory was found to be significantly worse after 4 weeks than after one week ($p < 0.05$ for both).

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Voice Line-up, Ear Witness, Speaker Identification

D30 Measuring What You Manage — Performance Metrics in Digital Evidence

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After attending this presentation, attendees will have a framework for developing performance metrics in digital evidence laboratories.

This presentation will impact the forensic community and/or humanity by providing useful information to the digital evidence community, and the forensic science community as a whole, concerning the use of performance metrics to manage forensic laboratories.

Digital evidence is one of the newest disciplines in forensic science. The examination of digital evidence has been practiced both formally and informally since the late 1980s. The Defense Department, the Drug Enforcement Agency, the Federal Bureau of Investigation, and the Treasury Department developed formal programs early in the 1990s. Many other law enforcement agencies and a number of forensic laboratories also developed programs since those early days.

Some of the agencies modeled their digital evidence programs on traditional forensic programs, in some cases making digital evidence examination a separate unit or even laboratory within a laboratory system. Most recently, there have developed an entire system of Regional Computer Forensic Laboratories. ASCLD-LAB approved Digital Evidence as a discipline in 2003.

Regardless of the structure or hosting entity, the demand for digital evidence forensic services has grown at a phenomenal rate. The numbers of requests, examinations, and volume of evidence in each case have all expanded faster than the growth in resources which has resulted in tremendous pressure on managers to intelligently grow and manage their programs.

There is a management axiom attributed to Kaplan and Norton that states: "You cannot manage what you cannot measure". Legendary management guru Peter Drucker goes on to say that "what gets measured gets done." Both recognize that the ability to measure performance is critical to effective management.

This paper will discuss the role of performance metrics in digital evidence units, sections, and laboratories, the different types of management metrics and will provide the results of an informal survey of current practice in digital evidence laboratories.

Digital, Management, Metrics

D31 CD-ROM Write Options Affect Calculation of One-Way Cryptographic Hashes

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After attending this presentation, attendees will develop an understanding of the interplay between CDROM file systems and cryptographic hashing tools.

This presentation will impact the forensic community and/or humanity by assisting examiners to avoid incorrectly interpreting the results of hashing algorithms and will be able to develop protocols which will prevent obtaining incorrect results.

One-way cryptographic hashes (or 'hashes' for short) are mathematical algorithms applied to digital media. A common use of hashes in forensics is to demonstrate that digital media has not changed (i.e., not been tampered with subsequent to seizure). The application of a hashing algorithm to a piece of digital media (a file, a forensic image, etc.) should always result in the same unique number, typically of size 128 or 160 bits depending on the particular hashing algorithm used. Change of a single bit on the digital media will result in a significant change to the resulting hash, indicating that the contents of the media have changed.

While validating several comparable hashing software tools against a CD-ROM developed for a competency test several anomalies were found, including the inability of some tools to hash the CD-ROM at all (i.e., the tool 'errors out'), and other tools returning different hashes. Replicating the same tests with the same tools and CD-ROM on different hardware resulted in the same anomalous results. (This eliminated the hardware as the possible explanation of the problem). Therefore two explanations were postulated. The first was that the software tools were not written properly. This solution was eliminated because of the widespread use of these tools in digital forensics and computer security research and practice. It was surmised that the write options used for the CD-ROM affected the ability of the hashing tools to properly calculate the hash.

There are several options that can be manipulated when writing CDs, including disk-at-once versus track-at-once, long versus short file names, multi-session versus single session, and to finalize the CD, to name a few. Note that these options do not change the actual files written to the CD, but only add 'overhead' to the CD. A fully crossed experiment was conducted combining several CD write options across five commonly used hashing tools. The results indicated that the anomalies disappeared when CDs were written using the disk-at-once option. The anomalies reappeared when using the track-at-once option.

The results of the experiments indicate that the options used when writing CDs affect the ability of different tools to properly hash a CD. This may be of great importance in a case, particularly when the expert witnesses use different tools to hash a CD and obtain different results. This kind of incident may cause doubt in the minds of the jurors that could have an adverse impact on the results of a case. This research proposal intends to extend this research to include DVD-ROMS, DVD-RW (read-write) as well as CD-RW (read-write).

Digital Media, Computer Forensics, Authentication

D32 The Role of the Qualified Radiographer in Forensic Investigations

Nancy S. Adams, BS, Itawamba Community College, 202 Milford Street, # 155, Tupelo, MS 38801*

After attending this presentation, attendees will gain insight into the educational requirements for qualified radiographers and develop awareness for the unique skills the radiographer offers in forensic science.

This presentation will impact the forensic community and/or humanity by introducing this important but unrepresented discipline to the American Academy of Forensic Sciences and increase awareness of the value of the highly skilled radiographer to the forensics team.

Mother Nature is on a rampage, or so it appears from recent naturally occurring catastrophic events. Terrorist attacks are escalating around the globe. Although the world's population growth rate has slowed down, projections indicate population levels will be nearly 9.1 billion people by 2050, nearly a 50% increase compared to 2002. The population levels, coupled with extreme weather and unimaginable terrorist activity, present a horrific opportunity for mass tragedies unlike any ever encountered. Add to this mix the genuine threat of pandemics, and humanity faces the real possibility of a staggering number of deaths. The demand for identification of the deceased and determination of causes will be significant. Although radiology has always been a component in forensic investigations, the importance of having qualified, experienced radiographers as team members has not been recognized by the forensic scientific community. The appropriately trained, experienced radiographers, many of whom possess baccalaureate or advanced degrees, offer a unique and valuable set of skills and knowledge to aid in identification and determination of cause. This presentation will provide an overview of the curriculum and clinical education required of radiographers for national board certification. Criteria for advanced practice in the field of forensic radiography will be offered, and the practical skills the radiographer can bring to forensic imaging are discussed. Although the radiographer's scope of practice does not include interpretation and diagnosis, no one in the medical profession critiques the images for positional and technical accuracy or looks at more images than the radiographer. These skills make the radiographer especially adept at recognizing anatomical and positional variations and comparing ante- and postmortem images. These skills also ensure that the radiographer can produce images that correctly mimic antemortem images. And the certified radiographer has been properly educated and trained in a variety of imaging equipment, including C-arms, CT, and digital imaging equipment. The radiographer must be innovative and adaptable as they deal with the greatest variable known to medicine, the living human being. These attributes enable them to function in a variety of conditions and situations that are appropriate when dealing with the dead as well. As a final deliberation, forensic pathologists and other forensic scientists must be mindful of the religious beliefs that prohibit invasive autopsies. This is just one more aspect where the forensic radiographer can be of invaluable service.

Identification, Radiographer, Images

D33 The Excavation, Recovery, and Analysis of Remains From a Series of Interrelated Sites Containing the Mortal Remains of Kosovar Albanians

Jon Sterenberg, MS, Rene Huel, BS, Ana Kron, BA, Jeffrey Buenger, JD, Ana Milos, MS, Arijana Selmanovic, MS, Adnan Rizvic, BS, and Sharna Daley, MS, International Commission on Missing Persons, Alipasina 45a, Sarajevo, 71000, Bosnia and Herzegovina; Marija Djuric, MD, PhD, University of Belgrade, School of Medicine, Laboratory for Anthropology, Department of Anatomy, 4/3 Dr Subotica, Belgrade, 11000, Serbia; Dusan Dunjic, MD, PhD, Institute of Forensic Medicine, School of Medicine, University of Belgrade, Belgrade, 11000, Serbia; and Danijela Djonic, MD, University of Belgrade, School of Medicine, Laboratory for Anthropology, Department of Anatomy, 4/2 Dr Subotica, Belgrade, 11000, Serbia*

After attending this presentation, attendees will understand the complexity of undertaking the excavation and recovery of hundreds of victims from a series of interrelated mass graves using archaeological techniques, the problems that these type of highly political sites can produce, and how a combination of teams from different disciplines can work together to effect a common goal i.e., identification and repatriation.

This presentation will impact the forensic community and/or humanity by providing a broader appreciation of the multidisciplinary inter-political process required for the comprehensive investigation of crimes against humanity and genocide.

During the recent conflict in Kosovo 1999 many hundreds of Kosovar Albanians were killed by various Para-military, military and police units. Following their deaths their remains were collected, often in specific groups, loaded into trucks and transported and interred within a series of large primary mass graves located within a military complex north west of the city of Belgrade.

As part of the International Commission on Missing Persons work within the region to assist in the location, recovery, identification and repatriation of remains related to this and other conflicts, a government initiated project was put into place enabling ICMP experts to attend and undertake the recovery, and DNA led identification of these remains. In conjunction with the recovery anthropological and pathological analysis was undertaken by the Belgrade Institute of Forensic Medicine.

Two separate but related mass graves were exhumed by the Belgrade Institute of Forensic Medicine in 2001. With the assistance of archaeological and anthropological experts from ICMP in 2002, a further three mass graves and two small but important stratigraphically related anomalies were excavated to build a picture of the events that occurred at the site.

In total the remains of 870 individuals were recovered in a variety of decompositional states and with a wide range of associated forensic information.

This paper will attempt to briefly outline the political situation at the time of ICMP involvement, the process by which the ICMP archaeological team set about locating the individual sites and remains including the use of non-invasive geophysical 'resistivity' and electrical imaging, the method of recording applied to all sites and remains encountered, the process of DNA sampling and testing and the final political problems encountered during the repatriation process.

Two further linked papers will also be presented, 2] a description of the anthropological data obtained at the sites, and 3] a review of the DNA technology used by ICMP to identify the remains. This will include a brief description of the method of the blood collection from surviving family members and the use of the DNA as a means of support for the archaeological observations made during the excavation.

Mass Graves, Excavation, Political Arena

D34 Batajnica: The Contribution of Anthropological Data to Identification of Mortal Remains of Kosovar Albanians

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After attending this presentation, attendees will understand the complexity of undertaking the excavation and recovery of hundreds of victims from a series of interrelated mass graves using archaeological techniques as well as some of the problems that these type of highly political sites can produce and will gain some knowledge of how a combination of teams from different disciplines can work together to effect a common goal i.e., identification and repatriation.

This presentation will impact the forensic community and/or humanity by providing a broader appreciation of the multi-disciplinary inter-political process required for the comprehensive investigation of crimes against humanity and genocide.

During the recent conflict in Kosovo 1999 many thousands of Kosovar Albanians were killed by various Para-military, military and police units. Following their deaths their remains were collected, often in specific groups, loaded into trucks and transported and interred within a series of large primary mass graves located within a military complex north west of the city of Belgrade. As part of a combined forensic operation between ICMP and the Belgrade Institute of Forensic Medicine, experts from the Laboratory for Anthropology and Institute of Forensic Medicine in Belgrade participated in the recovery and identification of 870 bodies of Kosovar Albanians interred in the mass graves at Batajnica, near Belgrade.

Of these bodies, 136 were legally identified by the end of 2003 providing an opportunity for the forensic experts to evaluate any post-mortem findings of classical markers of identity. This paper will attempt to outline the contribution of anthropological data in identification of this first group of identified individuals.

Sex and age at death of young to middle-aged adults were reliably determined but old adults were markedly under-aged. Stature was reconstructed reliably in 77% of cases. Dental status contributed little to identification efforts. In no case did classical markers of identity require rejection of the DNA-based identification. It is concluded that: sex determination from pelvic bones is very reliable, as are age at death estimates from pelvic and rib standards for young to middle-aged adults but that uncertainty intervals for age at death in older adults be broadened or refined by creation of local osteological standards. It is recommended that: a) more effort should be expended to obtain good dental records by using local dental expertise; b) local osteological standards for age estimation of older persons be created; and c) broader age intervals be chosen (+/-5 years in young adults and +/-10 years in adults older than 50 years).

Kosovo, Anthropology, Sex and Age Assessment

D35 Batajnica: The DNA Analysis of Remains From a Series of Interrelated Sites Containing the Mortal Remains of Kosovar Albanians

Rene Huel, BS, Ana Milos, MS*, Adnan Rizvic, BS, Jon Sterenberg, MS, and Ana Kron, BA, International Commission on Missing Persons, Alipasina 45a, Sarajevo, 71000, Bosnia and Herzegovina*

After attending this presentation, attendees will understand the complexity of undertaking the excavation and recovery of hundreds of victims from a series of interrelated mass graves using archaeological techniques as well as some of the problems that these type of highly political sites can produce and will knowledge of how a combination of teams from different disciplines can work together to effect a common goal i.e., identification and repatriation.

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As part of the International Commission on Missing Persons work within the region to assist in the location, recovery, identification, and repatriation of remains related to this and other conflicts, a government initiated project was put into place enabling ICMP experts to attend and undertake the recovery and DNA led identification of these remains. In conjunction with the recovery anthropological and pathological analysis was undertaken by the Belgrade Institute of Forensic Medicine. DNA samples were taken during the autopsy procedure at site.

In total the remains of 870 individuals were recovered in a variety of decompositional states, the ICMP field staff undertook a controlled temperature based record of all remains recovered from the sites over a period of days, the results of which have been previously presented at AAFS.

This paper will attempt to briefly outline the relevance of the number of samples taken, type of sample, the statistics for percentage of success and the success of blood samples to bone matches. The success of the application of 'blind' coding bone and blood samples makes the ICMP system a non-political based impartial process. Sampling procedures at the ICMP International Coordination Division and ICMP DNA labs allows staff to work on any sample in complete anonymity.

The success of the blood collection campaign which was specifically designed to communicate the use of DNA together with the importance of giving a blood sample was designed to target the surviving families and together with DNA assisted identification allowed for 95% of the recovered remains to be positively identified and repatriated to families in Kosovo. The remaining remains are awaiting repatriation.

The entire process combining ICMP and Belgrade Institute of Forensic Medicine experts within the excavation, recovery, blood collection, DNA analysis, and final repatriation of these remains is one success that hopefully has led to a more stable region.

Mass Graves, DNA, Anthropology

D36 Forensic Geophysics: Can This Discipline Save CSI Time and Money?

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After attending this presentation, attendees will discover various geophysical techniques available today that can reduce search time for buried evidence in various substrates.

This presentation will impact the forensic community and/or humanity by enlightening the forensic disciplines to the assets of forensic geophysics regarding searches for buried evidence. Attendees will learn how this discipline can determine exact location of evidence within a minimal amount of time utilizing non-invasive, non-destructive techniques.

Geophysical methods have been applied for decades in subsurface geological investigations for oil and gas exploration, as well as environmental issues. However, the forensic utility of geophysics has only recently become generally appreciated. The use of geophysical methodologies, such as Ground Penetrating Radar (GPR) and Electromagnetic (EM) sensing has proven invaluable in the location of buried evidence within various mediums. GPR can detect burial sites (homicide or otherwise) in natural soil or concrete. The advances of EM systems have improved to the point that some EM antennas can discriminate between metal and non-metal objects in the ground. With this more capable technology, targeted objects can range in size from a buried rifle to an expended bullet in a tree.

Forensic geophysics can assist law enforcement in locating clandestine graves and buried evidence with non-invasive procedures. The "line search" technique is replaced with a GPR and EM grid search that generates real-time data pinpointing the exact location of evidence. This data is also used to produce scaled maps documenting where the evidence was found. Forensic geophysics can help eliminate long hours dedicated to search and documentation allowing law enforcement personnel to concentrate on the task of perpetrator apprehension.

Geophysics, Electromagnetic Imaging, Ground Penetrating Radar

D37 Applications of Side Scan Sonar Technology to the Detection of Human Remains in Underwater Environments

Eric B. Emery, PhD, Joint POW/MIA Accounting Command, Central Identification Laboratory, 310 Worcester Avenue, Hickam Air Force Base, HI 96853*

The goal of this presentation is to introduce a baseline data set of acoustic images that illustrate the feasibility of using side scan sonar to detect submerged human skeletal remains in various stages of disarticulation. Preliminary data suggest that the uniformity versus irregularity of the substrate that supports the remains, the configuration of the remains projecting above this substrate, and the presence or absence of associated clothing and personal effects are all significant variables that can affect overall image resolution and therefore the relative utility of this technology in forensic investigations.

This presentation will impact the forensic community and/or humanity by assisting federal, state, and local agencies tasked with locating and processing underwater scenes that contain human skeletal remains in various stages of disarticulation.

Side scan sonar, and other acoustic imaging technologies, have become an increasingly valuable search tool for first responders and law enforcement personnel engaged in locating submerged targets, such as

automobiles, downed aircraft, shipwrecks, and even drowning victims (Fish and Carr 1990; Dupras *et al.* 2006). Nearly all acoustic systems fall into the category of passive or active. Side scan sonar is an active system that uses a transducer mounted inside a torpedo-shaped “towfish” to generate and transmit signals through the water column in the form of high frequency acoustic energy bursts. The reflected echoes of these signals are sensed by the transducer and passed along a tow cable to a view screen and recorder where they are translated into a plan image of the floor surface. Objects and other features with a significant profile above the floor may also be detected in these images. When deployed correctly, by an experienced operator, side scan sonar can be used to systematically cover large search areas in a noninvasive manner, identify targets of potential forensic interest, and preserve their depositional integrity prior to a diver reconnaissance survey and/or recovery operation.

Previous studies have shown that there is a general sequence of skeletal disarticulation that follows the disappearance of soft tissue from remains submerged in aqueous environments, provided that they are not rapidly introduced to anoxic or anaerobic conditions (e.g., burial in sediment) prior to the onset of advanced decomposition (Haglund 1993; Sorg *et al.* 1997; Boyle *et al.* 1997; Martin 1999; Haglund and Sorg 2002). Given this information, the key question then becomes: at what point in the disarticulation sequence can side scan sonar no longer be used effectively to determine the presence or absence skeletal remains? And what types of scene formation processes result in remains deposits that are best suited for acoustic imaging? This initial project, which is still ongoing, attempted to image a fully articulated skeleton, a partially disarticulated skeleton, and isolated skeletal elements (both with and without associated clothing and personal effects) using a MarineSonic Neptune Side-Scanning Active Sonar. Each of these experimental scenes were laid out in the same configuration along three different types of seafloor composition—i.e., hard sand, suspended silt over sand, and coral. Preliminary results indicate that skeletal configurations with a significantly exposed horizontal surface area and vertical profile, on a relatively uniform substrate, can be effectively imaged using underwater acoustic technology.

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Side Scan Sonar, Human Skeletal Remains, Underwater Scene Detection and Processing

D38 Underwater Body Recovery Procedures in Adverse Conditions

Eliza L. McUne, MCJ, Franklin County Coroner's Office, 520 King Avenue, Columbus, OH 43201; and John E. Gagnon, Columbus Division of Police, 120 Marconi Boulevard, Columbus, OH 43215*

After attending this presentation, attendees will have a basic understanding of how to recover a body from an underwater scene, while enduring adverse conditions in a river and reservoir system. The attendee should understand the importance of the process and procedures for retrieving a body and items of evidentiary value, while preserving and maintaining their integrity.

This presentation will impact the forensic community and/or humanity by demonstrating the consistency, accuracy, and versatility necessary to all investigation procedures.

Underwater recovery of a body from a reservoir and river system is difficult in the best of circumstances. Retrieval of submerged human remains subject divers to unique and often dangerous conditions. These include natural impediments, strong currents, zero visibility, toxic chemicals, entanglement, entrapment, and water temperatures in the 30 degree Fahrenheit range. Historically, body recovery has been a haphazard venture, using such archaic methods as chains and hooks to “drag” the bottom for the body. Oftentimes, untrained and inexperienced divers are sent into the water, jeopardizing their personal safety, as well as preservation of the body, evidence, and the scene. Failure to properly retrieve the body and evidence can lead to unreliable results, inaccurate analysis, and failure to resolve the case. This presentation will address why and how to successfully recover human remains and any evidence associated with them.

A successful underwater body recovery requires a precise, methodical, coordinated approach to locate, retrieve, and preserve human remains and associated evidence. Dive team members must be versatile due to the uniqueness of each dive operation. In this presentation, instruction begins with the point at which the body has been found. Divers must first document, diagram, and map the body's location and position, as proper documentation is crucial to an accurate chain of custody. Photographs should be taken of the human remains in situ to document their position and condition. When this is not possible, due to low or zero visibility, the body is photographed when returned to the land.

Divers must then search the area immediately around the body for additional items, using a radiating circular pattern. The size of the search area is dependant upon the condition of the remains and case circumstances. Items recovered often include detached body parts, weapons, clothing, or jewelry. Typically, divers work in low to zero visibility, using only the sense of feel and one gloved hand, as the other hand is tethered to a tender on the surface. “Feeling” for evidence must be slow and methodical to avoid missing potential items of evidentiary value. When searching for heavy or sunken items, a diver may have to immerse their arm into the thick, sludge-like muck of the river bottom.

Finally, the body should be placed in a specially designed body bag while still underwater, in the same position as found to avoid loss of evidence on or attached to the body. Such evidence may include blankets, ropes, chains, safes, and cinder blocks. Several divers and lifting devices may be required during removal to prevent damaging the body and related evidence. Bagging the body underwater also protects it from unwanted media attention and observation by the decedent's family. Bodies removed from the water are transported to the medical examiner's office for examination and autopsy.

Body, Underwater, Adverse Conditions

D39 Field Observations of Bone Deposition in Six Rivers

Thomas V. Evans, MA, 231 109th Avenue SE, Bellevue, WA 98004*

After attending this presentation, attendees will learn about the current hypotheses of bone transport and deposition within fluvial (river) systems and field evidence that suggests which parts of these hypotheses are valid and how this information could help investigators make informed decisions concerning searches for additional skeletal material from disarticulated and scattered remains.

This presentation will impact the forensic community and/or humanity by demonstrating what parts of existing bone transport theory are supported by observations from the real world as well as what gaps exist in understanding leading to more focused searches for skeletal remains and higher success rates in additional bone recovery. Once the accuracy of the current theory is determined as well as its deficiencies, a predictive theory of bone transport and deposition that can guide the recovery of skeletal remains found in rivers, can be identified.

Attendees will be exposed to the current hypotheses of bone transport and deposition within fluvial (river) systems, and field evidence that suggests which parts of these hypotheses are valid. This information could help investigators make informed decisions concerning searching for additional skeletal material from disarticulated and scattered remains.

Huzzah Creek (Missouri), Levelock Creek (Alaska), a tributary of the El Kejanero River (Kenya), Lugga Maji Chumvi (Kenya), Lugga Mbololo (Kenya), and an unnamed Lugga (Kenya) were all surveyed on foot or by swimming for their modern bone contents. When skeletal material was located information concerning its orientation, burial, modifications, and geologic context were recorded. The resulting observations were compared to the predictions made by previous authors concerning bone transport and deposition to determine which hypotheses are supported by the evidence. Field data was also compared to flume data to determine how applicable such experiments are to real world fluvial systems.

The preliminary data suggests that the author's current hypotheses concerning bone transport and deposition are incomplete however portions are supported by the field evidence. Flat bones lie against the river bed and do not appear to be moving rapidly. Long bones are generally found parallel or perpendicular to flow and likely have variable transport velocities. Long bone shafts that have been cut on either end orient themselves parallel to flow, do not move readily, and are deposited over rapidly. Small bones or bones of irregular shape tend to be transported faster than other bones. Bones with concavities tend to lay concave surface downward and move slower compared to other bones. Lastly bones are preferentially found in places of lowered flow velocity, like behind obstructions or vegetation. Limited observations also suggest that articulated units tend not to move as fast as isolated skeletal elements and large clasts and high energy are needed to produce marked rounding on bone surfaces. These observations are largely consistent with data from flume experiments with bones however a detailed comparison is not possible since the skeletal sample analyzed here is not large enough yet.

Additional observations were made that complicate the understanding of bone transport and deposition, including the presence of scour pits in the river bed above bones, which was not predicted or observed in flume experiments previously.

Practically the information in this talk will inform investigators what parts of existing bone transport theory are supported by observations from the real world as well as what gaps exist in understanding. This would translate in to more focused searches for skeletal remains, hopefully with higher success rates in additional bone recovery. Ultimately a predictive theory of bone transport and deposition is desired, one that can guide the recovery of skeletal remains

found in rivers. However the first step is to determine the accuracy of the current theory, then identify deficiencies and fill the gaps as needed.

Future research should focus on a comparison between experiments performed in the laboratory in conjunction with actualistic experimentation in fluvial settings. Since human remains are difficult to experiment with in the wild, an understanding of how different physical features of bones alters transport is desired, so the developed theory can be applied more readily to human remains.

Fluvial, Deposition, Bones

D40 Muddying the Waters With Red Herrings: Jurors, Juries, and Expert Evidence

Judith G. Fordham, BSc, LLB, Murdoch University, School of Biological Sciences and Biotechnology, Murdoch, WA 6150, Australia*

After attending this presentation, attendees will learn how to improve the presentation of forensic evidence based on feedback from in depth interviews with real jurors in Australia.

This presentation will impact the forensic community and/or humanity by demonstrating reliable information and practical solutions, and a few laughs!

Participants should acquire a realistic appreciation of the manner in which jurors and juries deal with expert evidence in actual trial situations. They will gain an insight into the way jurors and juries process and argue about expert evidence and integrate it with other evidence. Questions such as the following will be explored,

- When each side calls experts who disagree about the same fact situation, how does a lay juror approach his or her deliberations?
- What experts, lawyers, and judges can do to help a juror understand?
- How experts may enhance his or her credibility?
- Do we underestimate the capacity of the jury to assess expert evidence?

The presentation will be useful for both attorneys and forensic practitioners, giving insights into which methods of presentation of evidence work and which do not.

Proposition: Jurors, many without technical training and by definition requiring expert help to assess forensic evidence are required to:

- integrate that evidence with other evidence
- assess opposing expert interpretations of other evidence
- in unfamiliar circumstances
- with a group of strangers
- often without the most rudimentary aids to understanding

It has been suggested that the jurors, even in ordinary cases, are incompetent as fact finders, are unable to cope with technical or lengthy evidence, and are bedazzled by experts, often accepting what is said unquestioningly.

There have been many suggested reforms, ranging from provision of written copies of evidence, summaries, flowcharts, pretrial tutorials, allowing jurors to question experts and allow note taking.

Synopsis of the content: Data will be presented from exit surveys and extensive semi-structured interviews with real jurors after trials involving complex expert evidence. The study aims to

- Identify factors which inhibit or assist juror comprehension by examining the way jurors deal with expert evidence including juror perception of information, interpretation of facts both individually and collectively, application of case facts and ability to compare and contrast all evidence presented.-
- Provide information, not speculation, for experts, lawyers, and judges.

To the best of this author's knowledge, research of this nature has not been carried out in the "British" justice system. As a senior criminal trial lawyer and Associate Professor in Forensic Science, the author is able to provide a realistic assessment of the practical implications of the findings.

Conclusion: The so-called “CSI effect” may be an urban myth. The jury is more capable of following and fairly assessing expert evidence than commonly thought. Some jurors want radical changes, such as the ability to ask questions of experts.

Juries, Evidence, Forensic

D41 Enhancing Bloody Footwear Impressions: Infrared Photography Compared to Amido Black Treatment

James A. Bailey, PhD, Minnesota State University Mankato, 109 Morris Hall, Mankato, MN 56001*

After attending this presentation, attendees will understand: (1) a procedure for recording digital infrared images of bloody footwear impressions on dark and multi-colored fabric, (2) a procedure for developing bloody footwear impressions using amido black, and (3) the advantages and disadvantages of using digital infrared photography and amido black for enhancing the impressions.

This presentation will impact the forensic community by demonstrating the importance of enhancing bloody footwear impressions at crime scenes.

Footwear impression evidence is difficult to observe on dark or multi-colored fabric; therefore, impression evidence could easily be overlooked at crime scenes. Investigators should search for garments or fabric items that could contain bloody impression evidence although blood evidence may not be readily detected on the fabric items. Some chemical tests used for bloody footwear impression enhancement include: luminol, Hungarian red, Crowles double staining solution, aqueous leucocrystal violet (ALCV) and amido black. Some of these chemicals yield improved enhancement on porous surfaces and some yield improved enhancement on nonporous surfaces. The purpose of this presentation is to present the results of a study that evaluates infrared photography and amido black for enhancing bloody shoe impressions on dark or multi-colored fabric. Footwear impression evidence is probable at scenes where blood evidence is present.

In this experiment, 20 footwear impressions were prepared for infrared photography and subsequently treated with a solution of amido black (Naphthalene Black 12B), a protein dye stain that turns blue-black when it comes into contact with blood. A variety of fabrics including solid dark colors, multi-colored designs, floral prints, and plaids were selected for testing. The fabric samples also contained different weave types and fiber blends. The fabric samples were cut into pieces 15.24 cm by x 35.56 cm (6 in x 14 in) in size. Ten samples were 100% cotton, five samples were 100% polyester and five samples were mixed blends. The mixed blends included one sample of 90% polyester and 10% cotton, one sample of 50% polyester and 50% rayon, one sample of 72% polyester and 28% cotton and two samples that consisted of 60% cotton and 40% polyester.

Bloody shoe impressions on the fabric samples were collected by using the following procedure. A piece of 100% white cotton fabric was placed in a glass dish 22.86 cm x 33.02 cm (9 in x 13 in) and saturated with bovine blood. Each shoe impression was produced by stepping onto a piece of presoaked bloody cotton fabric in the glass dish and then by stepping onto a pre-cut fabric sample. The sample impressions were allowed to dry. Once dry, both color and infrared photographs were taken to enhance the impressions. The samples were then treated with a solution of amido black. The amido black solution was prepared by adding 0.2 grams of amido black to 90 mL of methanol and 10 mL of glacial acetic acid. Each sample was saturated with the amido black solution using a wash bottle while holding the sample in a glass dish at a 45 degree angle. After 2 minutes, the samples were washed with a mixture of 90 mL methanol and 10 mL glacial acetic acid to reduce background staining and dried at 20°C (68°F).

Digital infrared images were made with a 35 mm Nikon D-70 camera with an 18-70 mm f 3.5 – 4.5 G ED-IF AF – S DX Nikkor lens and a 67 mm #87 infrared Tiffen filter. The jpeg fine setting with a medium image size was used to record the exposures. The image file size for this combination of settings was approximately 1.6 mega bytes per image. Experimental camera settings were used to determine the most effective exposure. The lens to object distance was 22.86 cm (9 in). The shutter speed was approximately 2 seconds at f - 3.5 using daylight illumination. The results provide the investigator with a procedure to record optimum digital infrared images of bloody footwear impressions.

Of the 20 footwear impressions, 9 (45%) were enhanced using infrared photography and 11 (65%) were not. Of the samples enhanced, 4 (20%) were 100% cotton, 4 (20%) were 100% polyester and 1 (5%) was from the mixed fabric blends. The mixed blend fabric that was enhanced was 60% cotton 40% polyester.

Of the 20 footwear impressions, 11 (55%) were enhanced using amido black and 9 (45%) were not. Of the samples enhanced, 6 (30%) were 100% cotton, 1 (5%) was 100% polyester and 4 (20%) were mixed fabric blends. All of the footwear impressions on the mixed blends were enhanced by the amido black.

Infrared could be utilized to record images of footwear impressions on dark colored fabric because the procedure is nondestructive and the results are immediate. However, if the infrared image is unsatisfactory, amido black enhancement could be attempted as an alternative method on the evidence. Even though there is some background staining with the use of amido black it does enhance pattern details on some fabrics. Also, according to one study there have been successful attempts in DNA typing after using amido black for the enhancement of bloody impression evidence.

Infrared Photography, Amido Black, Bloody Footwear Impressions

D42 Cocaine Related Deaths in the Tarrant County Medical Examiner’s District, A Ten Year Study: 1996-2005

Nannepaga Zachariah, PhD, and Nizam Peerwani, MD, Tarrant County Medical Examiner’s Office, 200 Feliks Gwozdz Place, Fort Worth, TX 76104*

After attending this presentation, attendees will understand the abuse of cocaine related to sex, age, and race in the Tarrant County population.

This presentation will impact the forensic community and/or humanity by providing the trend of cocaine abuse over a ten year period.

Cocaine, a tropane alkaloid, is a powerful stimulant and is derived from the leaves of coca plant, a plant whose stimulating qualities are well known to the ancient people of Peru, and other pre-Columbian South American societies. The name comes from the coca plant plus the alkaloid suffix –ine. There is a long list of prominent intellectuals, artists, and musicians who have used the drug ranging from Sir Arthur Conan Doyle, Sigmund Freud, to President General Ulysses S. Grant. It is an illicit drug and excessive use can lead to convulsions, seizures, stroke, cerebral hemorrhage, or heart failure. Mixing with alcohol is a dangerous cocktail and can greatly increase the chances of sudden death. In fact it is the most common two drug mixture when sudden death occurs. The purpose of this study is to establish any pattern of cocaine related deaths, due to sex, age, race and geographic location in the Tarrant County Medical Examiner’s district, which serves a tri-county population exceeding 2.2 million, between the years 1996-2005. The data was collected from all cases of natural, accident, suicide, and homicide deaths. The cause of death being a mixed drug overdose, out of which, at least one of the drugs being cocaine. The data is summarized as follows:

Table 1. 1996-2005 Deaths Related to Cocaine – Cause of Death

Cause:	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Accident	37	48	31	43	40	40	41	65	65	45
Homicide	0	0	0	0	0	0	0	8	0	0
Natural	0	0	0	0	0	1	0	4	0	0
Suicide	0	0	1	1	0	0	0	9	0	0
Undeterm	1	3	4	2	1	1	0	3	0	0
Total:	38	51	36	46	41	42	41	89	65	45

Table 2. 1996-2005 Deaths Related to Cocaine – Among Gender

Gender:	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Female	8	7	9	13	11	10	7	18	14	17
Male	30	44	27	33	30	32	34	71	51	28
Total:	38	51	36	46	41	42	41	89	65	45

Table 3. 1996-2005 Deaths Related to Cocaine – Among Race

Race:	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Black	11	11	12	14	13	11	8	25	15	17
Hispanic	7	4	6	4	2	4	5	10	8	7
White	20	35	18	28	26	27	27	53	39	15
Other	0	1	0	0	0	0	1	1	3	6
Total:	38	51	36	46	41	42	41	89	65	45

Table 4. 1996-2005 Deaths Related to Cocaine – Among Age Groups

Age:	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0-19	2	3	1	2	1	2	2	6	6	1
20-29	10	9	6	13	8	6	8	15	14	11
30-39	16	20	14	14	19	14	13	22	14	11
40-49	6	15	13	12	9	15	15	31	18	15
50-59	4	3	2	4	4	4	3	14	12	7
60-69	0	1	0	1	0	1	0	1	1	0
70-79	0	0	0	0	0	0	0	0	0	0
80+	0	0	0	0	0	0	0	0	0	0
Total:	38	51	36	46	41	42	41	89	65	45

While there was no pattern observed by way of increased abuse of cocaine over the ten year period, the following was noted:

- Males have abused (76.9%) over females (23.2%).
- Abuse among races indicated whites predominately abusing (58.2%), followed by blacks (27.7%) and Hispanics (11.5%).
- Among the age groups studied, predominately it is 30-30yr. (31.7%), followed by 40-49yr. (30.1%) and 20-29 (20.2%).

Cocaine, Cocaine Abuse, Socioeconomic Status

D43 The “Jane Doe” Homicide - April 8, 1954, Boulder, Colorado

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On 8 April 1954, the nude body of a female was found by two Colorado University students along a creek bed in Sunshine Canyon outside of Boulder, Colorado. There was considerable decomposition and scavenger activity to preclude identification. The autopsy cause of death was essentially blunt force trauma. She was buried as a “Jane Doe” in Boulder’s Columbia Cemetery.

Fifty years later, the Vidocq Society of Philadelphia was asked for assistance in analysis and identification of the case. Two pathologists and an anthropologist exhumed the body and examined the skeletal remains.

Pictures: exhumation, remains, subsequent studies, facial reconstruction and law enforcement officers investigation, etc.

Decomposition, Exhumation, Identification

D44 An Overview of Elder Abuse With Assessment Tools for Medical and Law Enforcement Personnel

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After attending this presentation, attendees will understand the fundamentals of elder abuse, the characteristic patterns of injury consistent with the pathology of the human body in the aging process, and the necessary assessment tools for the proper identification of elder abuse as opposed to natural injury patterns.

This presentation will impact the forensic community and/or humanity by serving as a reference for the proper assessment of elder abuse by all medical and law enforcement personnel. In addition advocacy for the elder population in the American society will be stressed as to promote their safety.

Elder abuse encompasses a wide array of human mistreatment including emotional abuse, psychological manipulation, neglect and/or abandonment, and financial exploitation. Statistics show that in most cases, the abuse performed is carried out by a loved one or by persons' in which the victim has entrusted. A proper assessment is crucial for two reasons. First, the victim deserves to have the truth heard if a crime was in fact committed. Second, the perpetrator deserves equality and justice until it is determined that they have participated in the crime. Since some cases of elder abuse are misleading due to natural or accidental causes, it may be the case that the suspected perpetrator is innocent of the allegations.

Assessment tools for law enforcement and medical personnel include more than basic visual considerations. The word of the victim is the most considerable tool for assessing a possible crime; however, some victims are fearful to voice their concerns due to the possibility of more severe punishment by the abuser for doing so. It is then up to the investigative personnel to manage the situation for the benefit of the victim. Not only must a thorough physical assessment be completed, but also a psychological exam of both the victim and the accused perpetrator. It is also recommended that assessments be completed also upon the possibility of elder abuse. Data suggests that a personal interview of the possible perpetrator will ensure the physical and psychological safety for both parties involved by recognizing the possibility of a crime before it is committed.

Research on the topic of elder abuse will be gathered with the assistance of government officials and medical personnel familiar with the subject. Cases of elder abuse will be profiled to help identify a number of trends. First, a regional comparison within the state of Nebraska on elder abuse in small rural communities versus large cities will be examined to possibly provide helpful resources to other demographical areas of the country. This research will compare reported cases of elder abuse between different levels of population density to observe both similarities and differences in the likelihood of the crime based upon population concentration. Second, the circumstances surrounding the crimes will be compared to the injury patterns found. This information will assist law enforcement and medical personnel in determining criminal activity as opposed to an accidental death. The physical aspect of violence against the elderly, including obvious bodily harm and sexual assault, must be carefully assessed in order to determine whether the pattern of injury is accidental or inflicted by a second party. The natural aging process must also be taken into consideration upon physical assessment so as to not confuse normal physiological changes with the pathophysiological aspects of injury pattern in the elderly. Finally, trends will be compared surrounding the personal lives of the

victims' within the cases studied. These trends will be comprised of personal relationships, personal demographics, and lifestyle aspects. This will serve as an interpersonal assessment tool for all personnel assisting elderly persons at risk for abuse by giving situational data to assess for in the future.

Elder, Abuse, Assessment

D45 Atypical Wounding Patterns Caused by Rocket Propelled Grenades

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After attending this presentation, attendees will understand atypical wounding patterns resulting from the rocket propelled grenade.

This presentation will impact the forensic community and/or humanity by demonstrating how not all wounding patterns of grenades result in explosive injury patterns. This poster describes unusual wounds resulting from the rocket propelled grenade.

Background: Shoulder fired rocket propelled grenades have proved to be a potent weapon in the continuing conflict in Iraq. It can be considered one of the most successful antitank grenade launchers ever made. The RPG 7, (Rocket Propelled Grenade), launcher is a Soviet manufactured anti-tank weapon introduced to the battlefield in 1961 to replace the previous models following several revisions. It is robust, simple, lethal and one of the most common and effective infantry weapons currently in use. It is a shoulder fired, recoilless, muzzle loading, reloadable weapon. With a shape-charge warhead it is capable of defeating armor in all known armored vehicles. Its use was noted on the battlefields of Somalia, Iraq and Afghanistan. It is found in forty countries with manufacturing carried on in at least nine countries. The RPG 7 consists of a launcher and a rocket or warhead. The warhead is loaded into the front of the launcher. The effective range is considered to be from 150 to 300 meters however 50 meters is realistic with the untrained operator or when accuracy is warranted.

RPG damage is a factor of design, velocity, and distance. The grenade travels at a rate of 295 m/s with a range of 900 to 1100 meters. The blast radius is four meters. The resulting wounds are manifested as primary, secondary, tertiary, and quaternary blast injuries, but in some case a single unique ballistic wound is observed. Typical wounding patterns result from the physical and physiological response transmitted by blast and stress waves through the body with pathophysiological alterations. The use of modern body armor provides protection to the chest and abdomen from direct and secondary blast injury. The result is fragmentation wounding patterns. Atypical wounding patterns caused by RPG's result in a ballistic appearance.

Purpose: Illustrate atypical wounding patterns of grenades with a built-in rocket propulsion system.

Design: Retrospective review of unusual cases of ballistic wounding from RPG's on the battlefield.

Sample/Setting: Examples taken from battlefield fatalities will be shown to demonstrate wounding patterns.

Results: Typical wounding mechanisms result in fragmentation due to the explosive nature of blast response. Ballistic wounds produced by RPG's are infrequent and may result in perforating wounding patterns.

Conclusion: The RPG-7 is a simple, inexpensive, and readily available weapon and poses a significant threat to soldiers on the battlefield. The effectiveness of this weapon traditionally produces explosive injuries and infrequently a ballistic injury may occur.

Grenade, Ballistic, Wounding Pattern

D46 The Effects of Fabric on Muzzle-to-Target Distance Determinations

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After attending this presentation, attendees will understand the principles and methodologies for conducting distance determinations, the use of a density model for the dispersion of gunpowder particles and fabric types, if any, which may be problematic for such examinations.

This presentation will impact the forensic community and/or humanity by providing examiners who conduct distance determinations with a documented study validating the use of standard target material for comparison to various fabric types.

Muzzle-to-target distance determinations are often requested of forensic laboratory personnel to assist investigators in their determination of what events took place at a crime scene. Clothing items, such as shirts or pants taken from the victim, are commonly contaminated with blood or other biological materials, making them unsuitable to safely use as a target material. In addition, analysts at many forensic laboratories may not be authorized to alter evidence clothing for distance determination purposes. In order to circumvent these problems, most forensic laboratories use standard testing materials for muzzle-to-target distance determinations. Typical standard testing materials include white twill jean, blue denim and white knit cloth.

The purpose of this research project was to determine whether these standard testing materials provides an accurate muzzle-to-target distance determination, regardless of the type of fabric that was involved in the shooting incident. Patterns resulting from test firing at standard target materials were analyzed and compared to patterns resulting from test firing at various fabric types. The intent was to identify specific fabric types that may not produce valid conclusions when using the standard target material when such examinations are conducted. The methodology used nine by nine (9 x 9) inch fabric targets, a Ruger Model P89 caliber 9mm Luger semiautomatic pistol and Federal brand caliber 9mm Luger cartridges loaded with 147 grain Hydra-Shok jacketed hollow point bullets. This combination was selected because it is commonly encountered in the laboratory and the ammunition provides ample dispersion of gunpowder for comparison out to a muzzle-to-target distance of approximately forty-two (42) inches. Fabrics selected provided a variety of fiber blends, thread counts and weave types that represent clothing types often encountered in the forensic laboratory. Each type of fabric was test fired at approximate muzzle-to-target distances of contact, 1 inch, 6 inches, 12 inches, 18 inches, 24 inches, and 36 inches. Visual and microscopic examinations were conducted to identify any unusual physical properties such as burning, singeing, or melting of the fabric, as well as any gunpowder particles adhering to the cloth. The dispersion of the gunpowder on the targets was rated according to density. This examination was followed by the modified griess test in order to detect a nitrite pattern on the test fired materials. Subsequently, the sodium rhodizonate test was performed to detect a lead residue pattern on the test fired materials. The patterns developed from the various fabric types were analyzed for size and density and compared to the patterns detected on the standard target materials.

Results of the comparative analysis on each of the fabric types and indicate fabrics that might pose a problem when compared to the standard target materials will be presented. The results of these experiments will identify which fabric types, if any, should not be compared to standard target materials for muzzle-to-target distance determinations.

Distance Determination, Fabric, Gunpowder Residue

D47 Operational Issues With Forensic Light Sources: A Comparison of Effectiveness for Semen Identification

John J. Doyle, MS, University of New Haven, 191 Wooster Street, Apartment 3A, New Haven, CT 06511; Jillian Byrd, BS*, University of New Haven, 361 Alden Avenue Apartment B1, New Haven, CT 06515; and Henry C. Lee, PhD, Timothy M. Palmbach, JD, MLS, and Heather M. Coyle, PhD, University of New Haven, 300 Boston Post Road, West Haven, CT 06516*

After attending this presentation, attendees will have a greater awareness of the training required for alternate light source operation.

This presentation will impact the forensic community and/or humanity by demonstrating how critical alternate light source operation is for effective evidentiary discovery at a crime scene.

Unadulterated semen samples were placed on 5 by 7 inch pieces of white cotton in 100% and 1% concentrations to simulate a more realistic range of sample types that might be observed at crime scenes. The samples were viewed using a Mini Crimescope, an Omni Chrome, an UltraLite, and an Inova X5 unit at 300-400 nm and 435-470 nm with an Evident orange barrier filter. Two issues became paramount to the comparison: the use of different wavelengths for each color of light, and the utilization of conventional bulbs versus LEDs. Research indicated units using a range of UV wavelengths (300- 400 nm) produced less fluorescence than units that employed a fixed UV wavelength (i.e. 400 nm). Photographic evidence showed neither conventional bulbs nor LEDs held any distinct advantage.

Distance was evaluated by viewing and photographing both semen samples at 300-400 nm and 435-470 nm from 3 inches to 10 feet; photographing is not recommended beyond 8 feet. Results found distance was negligible for 100% specimens. However the 1% specimens were saturated by the light beam at 3 inches, subsequently drowning out the stain. By increasing the illumination distance, the 1% sample gradually faded and eventually became non-visible between 8 to 10 feet. At 36 inches the 100% sample was most easily viewed at 435-470 nm, whereas the 1% sample was most easily viewed at 300-400 nm, with optimal viewing at 1 to 3 feet for both samples. This illustrates the need to test various wavelengths with an evidentiary sample to maximize viewing effectiveness.

Viewing contrasts for 100% and 1% semen samples were examined using the Mini Crimescope and the UltraLite units with Evident, Melles Griot, and Tiffen orange filters at 300-400 nm, and 435-470 nm. The Evident plate provided optimal contrast for the 100% and 1% sample under 435-470 nm by creating a bright fluorescence on a dark substrate; this held true with both the Mini Crimescope and the UltraLite units. It is interesting to note the 100% sample viewed at 435-470 nm with the Tiffen orange filter provided better *color* contrast by creating an orange fluorescence and making the white cotton substrate appear blue. At 300-400 nm, the Evident and Tiffen filter provided equal contrast for the 1% sample using both the Mini Crimescope and UltraLite units. All filters provided equal contrast for the 100% sample viewed at 300-400 nm using the UltraLite, however Evident and Tiffen filters were equally favorable using the Mini Crimescope. An additional point of interest regarding wavelength and barrier combination was the manufacturer recommendation of using clear barrier goggles with a 300-400 nm wavelength. Contrary to the recommendation, results favored an orange filter for wavelengths between 300-515 nm.

A laboratory study of the practical application of forensic light sources with regard to common usage errors during evidence recovery will be presented. It is the opinion of the authors that comprehensive training be encouraged to troubleshoot the aforementioned issues, as well as any unforeseen circumstances that may arise.

Alternate Light Source, Barrier Filter, Fluorescence

D48 Ion Mobility Spectrometry for the Rapid Field Identification of Pharmaceuticals

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After attending this presentation, attendees will be briefed on a method for identification of unknown pills, detection of narcotics using a table top detector. After viewing this presentation, attendees will have an appreciation of the usefulness of Ion Mobility Spectrometry (IMS) as a tool for identification of unknown pharmaceuticals to distinguish different formulations and differentiate between excipients and active ingredients.

This presentation will impact the forensic community and/or humanity by demonstrating a possible new method for identification of unknown pills, detection of illicit narcotics is examined and showing the usefulness of IMS in identification of pharmaceuticals.

Development of analytical techniques for the field identification of illicit narcotics and prescription medications that are being abused or counterfeited is an area of interest to many law enforcement agencies. In particular, the illicit use of pharmaceuticals is a growing problem in the US. Ion mobility spectrometry (IMS) is a possible candidate for this type of analysis offering ease of use, rapid analysis times and low detection limits for a variety of pharmaceuticals. In this work, the feasibility of using tabletop IMS instruments for drug detection was investigated using commercially available IMS detection systems. A variety of over-the-counter and prescription medications, taken from the most current list of best-selling pharmaceuticals and ones known to cause false positives on field tests for narcotics, were analyzed and reference spectra were obtained and characteristic peaks were identified. The analysis was performed by taking a swipe of the surface of the pill using the manufacturer recommended swipes, which are directly inserted into the instrument, with no need for liquid extractions or any other sample preparation. When the pharmaceutical was a cream or liquid, a small amount of the material was spread on the swipe and inserted into the instrument. The instruments are so sensitive that it can detect amounts in the low nanograms of material. Because of the instruments high sensitivity, it was very easy to add too much material which would necessitate a long time between samples to clear the instrument. To minimize the effect of local environmental conditions, reference peak values were corrected for the local temperature and barometric pressure producing what are called reduced mobility values. Interestingly, many of the commercial and prescription medications give false alarms for a variety of illicit narcotics. This will require additional consideration before IMS can be used routine analysis for illicit narcotics. The ability of IMS to distinguish the active ingredients from excipients was also investigated. This may be relevant to identification of counterfeited pharmaceuticals that may have different excipient to active ingredient ratios. Finally, the ability of IMS to distinguish formulations with different doses has been studied. This work is currently being extended to also evaluate the detection of pharmaceuticals using walk thru portal based IMS systems. Such systems allow high throughput screening and may be relevant for drug interdiction at borders and transportation hubs and are currently installed in a number of airports in the US and abroad.

Pharmaceuticals, Spectrometry, Analysis

D49 Trace Detection Ion Mobility Spectrometry Analysis of Illicit Narcotics

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The goal of this presentation is to highlight the feasibility of using ion mobility spectrometry (IMS) for the rapid field identification of trace narcotics. The practical considerations addressed in the presentation should allow drug screeners to have a better understanding of ideal parameters that commercial instruments should be operated under as well as aid in the identification of sources of false positives.

This presentation will impact the forensic community and/or humanity by demonstrating how IMS is a practical tool for the rapid screening of illicit narcotics with high sensitivity. Its ability to detect particles invisible to the naked eye makes this technique ideally suited for detecting trace amounts of explosives, narcotics, and other forensic-related substances. The forensic community should have a better understanding of the environmental background levels that exist regarding drug screening as well as possible sources of false positives. Also, understand the sensitivity of the commercial instruments used to screen for drugs.

Current national priorities in homeland security have led to an unprecedented level of utilization of trace explosive detection systems for counter terrorism and law enforcement. The most commonly deployed trace explosives detectors are based on chemical analysis by ion mobility spectrometry (IMS). People who carry or handle explosives are likely to transfer residues on surfaces that they come in contact with or retain residues on their clothes. This residue contains discrete particles of explosive that can be sampled by an IMS system. Due to the low vapor pressure of most explosives (and narcotics), direct vapor sampling of these materials by IMS is problematic. Therefore, in most IMS systems, the particles collected are converted to vapor by thermally assisted desorption. IMS is essentially a molecular size analyzer, which measures the atmospheric pressure mobility of charged analyte molecules and compares them to a reference library of a known explosive and/or narcotic. Since most narcotics are efficiently detected by ion mobility spectrometry, this has raised the intriguing possibility of (dually) using the existing and widely deployed IMS explosives detection instruments as trace narcotics detection systems for interdiction of narcotics and controlled substances. Such a capability may be of particular interest to U.S. Customs and Border Patrol, the Drug Enforcement Agency (DEA), FBI, US Coast Guard and State and Local Law Enforcement.

This work highlights the ongoing research at the National Institute of Standards and Technology (NIST) aimed at determining the feasibility of using ion mobility spectrometry (IMS) for the rapid field identification of trace narcotics. A series of practical experiments measured fingerprint IMS spectra as well as the linear dynamic range and detection limits for a series of illicit narcotics including cocaine, heroin, THC, and methamphetamine. Typical detection limits for these compounds are in the range of 0.1-100ng, which corresponds to the detection of one single particle with a diameter of a few tenths of a micrometer. A multivariate parameter approach was used to determine optimal instrumental conditions for the different narcotics. Parameters explored include desorber temperature, drift/tube temperature, and inlet temperature. Due to the significant concern of determining that the target compound was correctly identified, a database was developed of false positive alarms and interferences resulting from a wide variety of over-the-counter medications, household, and personal care products. Excipients and/or diluents commonly found in street narcotics were also carefully screened to determine their effect, if any, on IMS response. In addition, practical sampling issues were studied including optimal swiping procedures for best sensitivity as well as the influence of

possible environmental background signatures that may be relevant to trace narcotics detection (for example, the widespread contamination of US currency by Cocaine). The identification and confirmation of compounds leading to false positive alarms was evaluated by using gas chromatography/mass spectrometry (GC/MS) from extracts taken from the swipes. From these experiments, it has been determined that IMS is a practical tool for the rapid screening of illicit narcotics with high sensitivity. Its ability to detect particles invisible to the naked eye makes this technique ideally suited for detecting trace amounts of explosives, narcotics, and other forensic-related substances. One significant issue of concern is the potential for a high degree of false positive alarms due to environmental background and the low resolution of the technique. This suggests that the combination of IMS with an initial separation step such as GC may be important for continued development of this approach for practical field analysis.

Illicit Narcotics, Trace Detection, Ion Mobility Spectrometry

D50 The Effect of Speed on Bloodstain Patterns Found on the Exterior of a Moving Vehicle

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After attending this presentation, attendees will learn about the minimum speed required for blood from a beating incident to exit a moving vehicle and spatter back onto its exterior.

This presentation will impact the forensic community and/or humanity by providing bloodstain pattern analysts and investigators reliable data on which they can base their interpretations or crime scene reconstructions.

When a patrol officer approached a vehicle on the side of the road, two of its occupants were standing outside claiming they got into a car accident while the third occupant lay dead in the front passenger seat. The vehicle sustained minor exterior damage; however, the observable bloodstain patterns on the exterior surface of the vehicle were inconsistent with the story. Although blood spatter interpretation has been described in vehicular crime scenes, the literature is lacking in studies illustrating blood escaping from a moving vehicle and subsequently spattering back onto the exterior frame of that vehicle. This study sought to determine the minimum speed at which blood resulting from a beating incident, would exit a moving vehicle and spatter back onto its exterior rear passenger window. A blood soaked sponge was positioned on the right scapula of a face down mannequin and placed in the front passenger seat of a sport utility vehicle (SUV). While the front passenger window was rolled down, the sponge was struck 3 times with a blunt force object while the vehicle traveled at 1 of its 5 variable speeds until the presence of blood spatter was noticeable on the rear passenger window of the SUV. Brown butcher paper covered the rear passenger window of the SUV and was used to capture the visible spatter, which was subsequently recorded and photographed. A total of 16 trials were completed, resulting in perceptible medium impact blood spatter at a minimum speed of 30 mph. This result was successfully repeated during three additional trials.

Bloodstain, Moving, Vehicle

D51 Technological Integration and How it Affects the Forensic Resource

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After attending this presentation, attendees will have an insight into how the forensic resource can be affected by the introduction of novel technology into the operational framework of investigative practice. Methods will be suggested which could be employed to implement novel technology within the operational infrastructure of forensic investigation.

This presentation will impact the forensic community and/or humanity by presenting an approach to integrating technology within the domain of forensic investigation, one which is based upon attaining a user centered design concept and one which provides systems level functionality. The impact of this will be the implementation of relevant, cost effective technology through understanding system requirements and thus reducing the potential for adversely affecting the quality of the forensic resource.

The quality of forensic evidence is affected by the recovery process. The effectiveness of subsequent forensic analyses and consequential examination depends on the quality of the processes employed at the recovery stage. This presentation highlights research looking at technological and methodological change to support evidence recovery and how changes affect the quality of the recovery process, and consequently, the forensic resource. A case study will be presented which will look at the effects of technological change to law enforcement agencies, particularly how the introduction of new working practices and new technologies into organizational infrastructures lead to decreases in performance, rather than the increases which were anticipated. The case offers an insight into where integration problems exist and the complexities involved in rectifying the situation. Change appears to affect the forensic performance of the crime scene investigators, and as a consequence of the perceived dip in performance, a period of modification to technological support and to the methodologies employed needs to be undertaken. Poor integration strategies can be detrimental financially and operationally, this can impact on morale and the working culture of the team. The research looked at the bureaucratic responsibilities and analyses the consequence of change to other practitioners within the investigative process. Often studies that explore change point to problems in the integration strategies; on many occasions there is a failure to consider the complex interdependencies that connect different parts of the organizational 'system'. Forensic investigation is an example of this notion, where, very often, evidential quality, or continuity, is affected by the work of others in the chain of investigative process. The process of re-description is often dependent on understanding how the system operates from beginning to end, particularly how the investigation builds and how the accumulated information is displayed and utilized throughout each stage. In this work, a simple description of such interdependencies is adopted. Understanding, attained through partnership, enables future research to be embedded in the notion of user centered approaches to designing relevant technology for matters concerning forensic science. Focusing on systems level functionality, and supporting the forensic resource through automating processes allows the crime scene investigator greater time at the scene, whilst encompassing the bureaucratic and administrative requirements of the modern police service. The information acquired throughout this research is being used to determine what is prevalent to the investigator, and consequently, others involved in the investigation. By considering the narratives used and the collaborative requirements for information management and forensic process, the data can be used to focus design on appropriate user based technology, methods to aid data capture, and connectivity to support the flow and management of pertinent information.

Technology, Crime Scene Investigation, User Centered Design

D52 Technology for Crime Scene Investigation

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After attending this presentation, attendees will have an insight into technologies being developed by researchers at the University of Birmingham to support forensic investigation. The presentation will highlight the requirements process and subsequent technology designed and developed to support the delivery of crime scene investigation and enhance the potential of the forensic resource to law enforcement agencies.

This presentation will impact the forensic community and/or humanity by introducing several concepts, incorporating wearable technology, shared analysis, augmented reality and enhancing connectivity throughout the investigative infrastructure.

To maximize the potential of the forensic resource the recovery process has to be performed in a manner that maintains the integrity of the exhibits and remain within the confines of the appropriate laws which govern evidence recovery. Providing that an adequate integration plan has been used, technology can improve the efficiency and the efficacy of the investigative process. A key issue relates to the digitization of data collected at the crime scene and the methods of connectivity utilized throughout the investigative process to disseminate and receive information. Additionally, methods of capturing pertinent data will be explored, removing the mundane aspects of paperwork, such as completing labels and logs, and also evaluating bureaucratic responsibility focusing on allowing the forensic investigator to concentrate on the scene examination. This research has focused on several aspects of technological innovation providing solutions which involve the use of wearable technology, case based reasoning, and augmented reality. The research has culminated in the participatory collaboration of domain professionals and design engineers to produce technology relevant to the domain. The technology will be presented along with responses of practitioners to the proofs of concept and prototypes. Using a technology acceptance model several designs were presented to Crime Scene Investigators in a series of workshops, the responses were measured using questionnaires, the results of which will also be presented. The research has provided an insight into how emerging novel technologies are affecting crime scene investigation and forensic process; it will also highlight the potential future for law enforcement technologies.

The results of research into technology designed to support forensic investigation will be presented. Several concepts will be introduced, incorporating wearable technology, augmented reality, and enhancing connectivity throughout the investigative infrastructure of law enforcement agencies. Pertinent issues relating to potential integration problems of novel technology will be discussed. In order to ask what affect a new technology might have on an organization, it is necessary to consider the nature of the organization, the tasks performed, and the people who will use the technology.

Crime Scene Investigation, Shared Analysis, Technology

D53 Kidnaping in Darke County: Post Offense Behavioral Analysis

James J. McNamara, MS, Behavioral Analysis Unit, NCAVC, FBI Academy, Quantico, VA 22135*

After attending this presentation, attendees will gain a better understanding of the criminal investigative analysis process. Also, how offender post offense behavior can be identified, analyzed, and used by investigators and medicolegal professionals to successfully solve cases.

This presentation will impact the forensic community and/or humanity by demonstrating how in the absence of significant crime scene/forensic evidence, or eyewitness evidence, there is another valuable tool that can help solve violent crimes: criminal investigative analysis. In this presentation the emphasis is specifically focused on offender post offense behavior, how it can be identified, analyzed, and used proactively to bring about a successful resolution to a case.

The purpose of this presentation is to provide investigators and medicolegal professionals with a better understanding of criminal investigative analysis as a tool in the resolution of violent crime investigations. This presentation will be highlighted with a case example involving an abduction/rape/murder in which there was no forensic evidence, a minimal crime scene and no eyewitnesses. The utilization of post offense behavioral analysis proved key in the resolution of this murder case.

The FBI's NCAVC is routinely consulted by federal, state, local and international authorities in a variety of cases involving violent crimes, especially sexually motivated homicides. The NCAVC has extensive experience in assisting federal, state, local and international law enforcement agencies in the analysis and investigation of sexually motivated murders, and has reviewed hundreds of sexual homicides for research purposes.

This presentation will demonstrate the value of criminal investigative analysis as a valuable tool by demonstrating how case detectives used a behavioral analysis provided by the NCAVC, specifically for their case, that focused on the offender's post offense behavior. The resulting investigative strategy provided by the NCAVC and the investigative work done by the case detectives, successfully resolved the case.

Upon completion of this presentation attendees can expect to have a greater understanding of criminal investigative analysis, offender post offense behavior and how it can be used effectively by investigators, especially in the absence of forensic or eyewitness evidence.

Post Offense Behavior, Behavioral Analysis, Sexual Murder

D54 Missing in Madison, Wisconsin: A False Allegation Abduction

James J. McNamara, MS, Behavioral Analysis Unit, NCAVC, FBI Academy, Quantico, VA 22135*

After attending this presentation, attendees will gain an understanding of false allegation crimes, the offenders who commit false allegation crimes and their motivation.

This presentation will impact the forensic community and/or humanity by providing a better understanding of false allegation crimes and providing information for better identifying, analyzing, and investigating false allegation crimes.

The purpose of this presentation is to provide investigators and medicolegal professionals with an understanding of false allegation crimes, the offenders who commit false allegation crimes and their motives as highlighted through a case example involving a false allegation adult abduction. This presentation will discuss false allegation crime and its parameters, motivation of the offender, forensic and investigative issues.

False allegations are an enormous burden to law enforcement. They consume time, money and manpower as well as generating frustration within the law enforcement agency and the community they occur in. If unresolved, they can cause the public appearance of failure by the police. The FBI's NCAVC is routinely consulted by federal, state, local and international authorities in a variety of cases involving violent crimes, to include false allegations. The NCAVC has extensive experience in assisting these various law enforcement agencies in the analysis and investigation of false allegation crimes, to include rape,

stalking, extortion, and abduction. The focus of this presentation is on the practical issues involved in investigating and analyzing a false allegation crime, and the benefits of input from a multi-disciplinary approach and the need for cooperation between professionals.

Upon completion of this presentation, attendees can expect to have a greater understanding of the “truth” about false allegation crimes, to include the differences between genuine and false victims, false allegation versus unfounded cases, and motivations of the offenders.

False Allegation, Factitious Disorder, Abduction

D55 False Allegation of Child Abduction

Mark A. Hiltz, BA, Kathleen E Canning, MS, and Yvonne E. Muirhead, MS, FBI, FBI Academy, Quantico, VA 22135*

After attending this presentation, attendees will have a better understanding of the dynamics and characteristics of child homicide cases in which the offender has reported the child as missing or kidnapped in order to cover up their involvement in the child’s death.

This presentation will impact the forensic community and/or humanity by demonstrating that one of the issues to be resolved in almost every missing child case is whether or not the parent(s) or some other person close to the victim is actually responsible for their disappearance. In the absence of a witnessed abduction or definitive forensic evidence it is often difficult to make that determination. The research project that this presentation is based upon is intended to provide insight into the dynamics and characteristics of these types of cases and direction to the law enforcement community responsible for their investigation.

The purpose of this presentation is to provide a better understanding of the dynamics and characteristics of false allegation of child abduction cases.

Parents and other caregivers are sometimes responsible for killing children who are under their care, and then falsely alleging that the child is missing, or has been abducted, in order to explain the child’s disappearance and/or to cover up their complicity in the crime. These cases cause significant problems for the law enforcement agencies charged with their investigation, inasmuch as, absent witnesses or definitive forensic evidence, it is difficult to distinguish between a valid kidnapping and a false allegation.

The FBI’s National Center for the Analysis of Violent Crime initiated a research project into these types of cases in order to gain a better understanding of the dynamics of false allegation cases, identify characteristics of these cases and how they may differ from true kidnapping cases, and to identify successful investigative strategies. Forty-nine (49) cases have been examined to date, and the key findings will be discussed during this presentation.

Child Abduction, False Allegation, Child Homicide

D56 How Women Victims of Intimate Partner Violence are Portrayed in International Medical Journals: A Study of Articles Published Over the Course of a Year

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The goal of this presentation is to encourage practitioners to reconsider how they treat women victims of intimate partner violence, that they might treat such patients with more respect for their autonomy.

This presentation will impact the forensic community and/or humanity by encouraging clinical research in this field and potential research partnerships.

Introduction: Intimate partner violence (IPV) is officially considered to be a ‘public health problem’ in France as stated in a government report published in 2000. Resources are being coordinated to assist doctors in the assessment, documentation, treatment, and appropriate referral of the women victims concerned.

Objective: To determine how women victims of IPV are represented in the medical discourse.

Method: For the year 2004, referenced publications were studied on Medline selected with the key words ‘domestic violence’ or ‘intimate partner violence’. Only papers focused on heterosexual couples were considered – all other couple groups were excluded. For each paper, the nationality, specialty practice, and bias of each author were evaluated as well as the type of journal each paper was published in.

Results: There were 621,643 referenced publication papers in 2004. The search yielded 1274 references of which 298 were relevant to the study. Thirty countries were represented, with a majority of the articles from the USA. Journals relating to public health, victimology, and gynaecology/obstetrics were the most present. IPV in itself is never defined but is always considered by its consequences or by the risk factors.

The publications concerned in majority the women (only 20 papers concerned the aggressor and 16 papers concerned the couple), treating mainly the epidemiological aspects, socio-demographic data, risk factors, and the consequences for the women’s health and that of the children.

The recommended therapeutic attitude always involves invoking judicial procedures.

Discussion: IPV seems to be mainly considered through the demographic data, and the absence is remarkable, in this series of papers at least, of clinical case studies which would allow to better understanding what goes on in the intimacy of violent couples. The woman is considered in isolation, completely passive, and not as part of a couple. No publication distinguishes between forced marriages and freely consented marriages. The woman is presented as fragile, incapable of asserting herself, who requires not only guidance but also, often, assistance.

In France, a debate has begun between those who consider the women as victims and those who have reconsidered this approach.

Conclusion: The medical publications studied give only an unclear image of the women, made up of statistical data, with a tendency to consider women victims of IPV as persons without autonomy, based on more or less relevant psychological data. In the series of papers studied, the lack of serious clinical case studies of persons concerned by IPV is notable. Progress can only come about through a considerable number of well researched case studies

Intimate Partner Violence, Women’s Status, Autonomy

D57 Revisiting the Groth/FBI Rapist Typologies: What Do Empirical Studies Have to Add?

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After attending this presentation, attendees will gain understanding of additional factors to consider in relation to rapist motivation and behavior.

This presentation will impact the forensic community and/or humanity by increasing appreciation for contribution of “academic” research to practical problems in forensic investigation.

Investigators of violent sexual crime have long been interested in a method of classifying rapists that could identify possible directions for the investigation. In the 1970s Nicholas Groth (1979) developed what could be called a behavior/motivation-based typology, based on his work with incarcerated offenders. This was further refined by Hazelwood & Burgess (1987) and is currently one of the more frequently used rapist typology systems in the United States. The system includes four categories: 1) power reassurance 2) power assertive, 3) anger retaliatory and 4) anger excitation. Corroboration of this typology has been based on case studies of incarcerated offenders and investigators' professional experience. From a research methodology viewpoint, this would be described as "qualitative" research.

Recently, there have been a number of studies in the US, Australia and England, which have used "quantitative" approaches insofar as they have applied multivariate statistical techniques to large data sets without using a *priori* conceptual frameworks. A variety of questions are posed in these studies such as whether or not there is behavioral consistency by a single offender across offenses, to what extent a particular rapist group correlates with demographic characteristics such as age and race, and which crime scene characteristics cluster together.

The purpose of this paper was to conduct a "meta-analysis" by comparing the quantitative research findings to the "Groth/FBI typology" to determine the extent to which the case study and large scale data analyses supported one another. At the time of this abstract submission, the full analysis has not been completed. However, preliminary results indicate that there is some behavioral consistency across offenses, some support for the four rapist groupings, particularly for the anger retaliatory and anger excitation categories. There is also some evidence of overlap between categories and the importance of "dynamic" factors such as victim behavior, environment, and drug/alcohol use in determining the characteristics of the rape process is likely to have been underestimated.

Rapist, Typology, Research

D58 Intimate Femicide, Accident or Natural Death

Bonita M. Porter, MD, and Michael S. Pollanen, PhD, MD, Office of the Chief Coroner, 26 Grenville Street, Toronto, Ontario M7A 2G9, Canada*

After attending this presentation, attendees will understand the importance of keeping an open mind when investigating sudden and unexpected deaths of women in the presence of their intimate partners will be discussed.

This presentation will impact the forensic community and/or humanity by demonstrating how a detailed case investigation and appreciation of the pathological evidence of disease processes can prevent a miscarriage of justice.

This investigation was initiated by a call to 911 at 5:24 am from a resident living in an upscale cottage community in Ontario. The residence was well known to police due to frequent complaints from the neighbors about the dogs barking.

A male reported finding his wife lying unresponsive on the living room floor. Emergency personal arrived on the scene to find the house in disarray. A woman was lying face down on the floor in front of the fireplace. The embers of the fireplace were noted to be red and hot. The paramedics turned her over, assessed her to be vital signs absent and did not initiate resuscitation. Other findings included a body warm to the touch, cool extremities, dilated pupils, mild rigor, facial cyanosis, and no lividity. The woman's body was clad in a plain nightgown, which was soiled and filthy. It was stained with urine and feces. Her feet were covered in dirt and the top of her right toe was cut. There was dried blood noted on the toes on her right foot. The coroner and police

responded. Given the nature of the scene the coroner requested additional investigation.

Ten years ago in Ontario, the death of a woman, originally classified as accidental, was determined to be a homicide by her spouse who staged a motor vehicle incident. As a result, all coroners were reminded of the importance of comprehensive investigations of unexpected female deaths where the only witness is a male partner. Subsequently, it also became a policy that all postmortems in cases of sudden and unexpected deaths of women in the presence of an intimate partner be conducted by a Regional Coroner's Pathologist, (a special designation by the Office of the Chief Coroner).

In compliance with this policy, the body of the deceased in this case was transferred to the Forensic Pathology Unit of the Office of the Chief Coroner in Toronto. A significant finding at autopsy was 2800 cc of fluid blood present in the peritoneal cavity.

Additional investigation revealed the following information. The deceased was 52-years-of age. Her husband was twenty years older. When questioned by police, he admitted to having had a "misunderstanding" with her the day prior to her death, but denied any violence. The couple was known to be in financial difficulty. The deceased was recently charged with fraud. The husband told police they had a million dollar home elsewhere, but the deceased refused to sell it as her child lived there.

According to the husband, the couple was up until about 3:00 am. Prior to going to bed, his wife asked for assistance in getting to the bathroom. He claimed that he could not lift her, and she could not walk, so she crawled. He last saw her in the bathroom and he went off to bed. One of the dogs woke him up at 5:00 am. He let the dog out and then went to check on his wife, expecting to find her sleeping on the couch. She was lying on the floor face down and he could not wake her. He then called 911.

Positive autopsy findings included peripheral wasting, a protuberant abdomen and slightly yellow sclera. There was a small amount of dried blood on the left nostril and a 2 cm ill-defined purple-red contusion on her chin. A 3 x 0.5 cm recent abrasion/contusion was noted over the right mastoid process and there were multiple red-purple contusions over the anterior surfaces of the shins. Fading purple contusions were noted over the arms. Fluid blood (2800 cc) was found in the peritoneal cavity.

Was this a death from natural causes, an accident, or foul play? The source of the hemoperitoneum will be revealed during the presentation.

Femicide, Investigation, Hemoperitoneum

D59 Predictors of Rape Associated With Injury in Adolescent and Adult Women

Patricia A. Crane, PhD, MSN, Child Abuse and Forensic Services, Inc., 810 Hospital Drive, Suite 190, Beaumont, TX 77701*

After attending this presentation, attendees will understand the importance of data collection in rape research, the significance of secondary data analysis in predictive model analysis, and implications for future rape research.

This presentation will impact the forensic community and/or humanity by demonstrating the value of data collection and research with rape victims of different ethnicities in various locations in the USA and is an initial step in model building for prediction of injury.

The purpose of the study was to identify predictors of physical injury (setting, victim characteristics, and forensic characteristics) in females over 12 years of age, adolescent and adult women, who have a medical history of rape by a male perpetrator and are examined in the emergency Department (ED). Severity of rape-related injury is linked to negative health consequences. Understanding the impact of injury severity and the associated predictors expands knowledge of the

experience of rape and women who are at greatest risk for long-term negative health consequences. Variables included regional setting, victim characteristics (age, ethnicity, and known or unknown perpetrator) and forensic characteristics (time from rape to examination, weapon presence, multiple perpetrators, and use of an evidence kit). Secondary data were evaluated that were cross-sectional retrospective clinical documentation of forensic examinations of women (n = 3318) 13 to 89 years of age (mean age 26.6; SD = 11.1) from three diverse regions of the US: the northeast, the southern coast, and the west coast. The results of multiple logistic regression models included main and interaction effects, primarily involving setting and ethnicity variables. The forward stepwise model ($X^2 [18] = 387.26, p = .001$) demonstrated adequate fit based on the Hosmer-Lemeshow X^2 goodness-of-fit results ($X^2 [7] = 5.72, p = .57$), and was a slightly improved fit over the backward elimination model ($X^2 [22] 398.12, p = .001$), which also had desirable Hosmer-Lemeshow X^2 results ($X^2 [7] = 7.47 p = .38$). The forward and backward models included 10 significant interactions: Setting C by age, Setting C by examination time of > 72 hours, Setting A by other ethnicity, Setting A by weapon presence, Setting A by examination time of 48-72 hours, Setting A by other ethnicity, Setting A by weapon presence, Setting A by examination time of 48-72 hours, and Setting A by multiple perpetrators, age by weapon presence, African American by examination time of 24-48 hours, African American by multiple perpetrators, other ethnicity by examination time of > 72 hours, and unknown perpetrators by multiple perpetrators. Conclusions are that ethnicity and location are important variables for data collection. Implications of this research 1) lead to refinement of data collection, 2) address the need for initiating research in the acute time frame, 3) inform tailored interventions for diverse victims, 4) link health and legal systems to improve overall forensic management of victims, 5) emphasize the need for multi-level funding allocation of resources for education, prevention and interventions to improve victim care.

Rape, Research, Violence Against Women

D60 Suspect Exams in Sexual Assault: How to Catch the Bad Guys

Melodie A. Brooks, BSN, YWCA of Toledo, 1018 Jefferson Avenue, Toledo, OH 43604; and Julie Cox, BS, Ohio Bureau of Criminal Identification and Investigation, 1616 East Wooster, #18, Bowling Green, OH 43402*

After attending this presentation, attendees will be able to identify the purpose and necessity of suspect exams, the correlation of suspect exams to sexual assault investigations, and the required elements of a suspect kit.

This presentation will impact the forensic community and/or humanity by raising awareness of the necessity for suspect evidence collection when investigating sexual assault cases.

Traditionally evidence collection has focused solely on the victim by specialized forensic examiners negating the fact that valuable trace evidence maybe found on the suspect. The suspect is a crime scene as much as the victim. Although, in many cases, no forensic evidence is found on the victim, evidence collection continues to focus exclusively on the victim. Within the context of a sexual assault kit the type of evidence collected may include clothing, bedding, and stains. These items when collected appropriately and transferred into evidence correctly can place the suspect at the scene of the crime. Other cases may involve digital penetration, oral penetration or the use of condoms in the assault. The type of trace evidence collected from these situations can be the key to success in an investigation and may only contain DNA from the suspect. Many forensic nurse examiner programs have collaborated with municipalities to provide evidence collection on the suspects of these crimes. The evidence collected on suspects can help corroborate a victim's account of events and complete the link between

crime scene, victim, and suspect. In contrast, the collection of evidence from a suspect can assist in the individual's exoneration. Suspect exams are not limited to sexual assault cases. In many scenarios, bite marks and fingernail scrapings can prove to be an invaluable source of DNA from the perpetrator of a crime. Furthermore, the suspects clothing can reveal an unrealized source of DNA. The timing of suspect evidence collection is crucial. The evidence on hands, clothing, or body parts can be washed away and lost forever. Juries continue to place demands on the forensic community to provide DNA. Through the development and initiation of suspect exams this demand maybe fulfilled.

Case studies where suspect evidence was pivotal in the investigation and prosecution of sexual assault. Emphasis will be placed on the key elements of correlation between the victim and suspect DNA will be presented. The suspect kit components will be reviewed with significance placed on types of evidence that maybe collected. A sample policy and procedure will be reviewed and available for distribution. In addition, participants will receive a sample consent form for review. The presentation is focused on information required to establish suspect collection.

Suspect Exam, Trace Evidence, Sexual Assault

D61 Male Sexual Assault: Fifteen Years Later What Has Changed?

Diana K. Faugno, MSN, 1351 Heritage Court, Escondido, CA 92027; and Patricia M. Speck, RN, PhD, UTHSC College of Nursing, 877 Madison Avenue, Room 653, Memphis, TN 38163*

After attending this presentation, attendees will be able to state two myths surrounding male sexual assault and list two vital factors to be included when reporting male sexual assault.

This presentation will impact the forensic community by assisting the attendee in exploring ways to obtain the history of a male victim of sexual assault in the Emergency Department or other setting when they present with physical or emotional injury associated with sexual assault. Currently most information about sexual assault relates only to the female victim. The attendee will become familiar with strategies for interacting with male sexual assault victims.-

The historical perspective about male sexual assault shows abduction and assault of males recorded in Greek mythology and during ancient Roman times. This type of assault signaled total defeat of the male. Males who were penetrated were considered to have lost their manhood and could no longer be a warrior or ruler. Gang rape was the ultimate punishment Romans used for adultery. The Persians and Iranians used male sexual assault for violation of sanctity of the harem.

Male sexual assault is extremely underreported. The National Forensic Protocol (2004) states that one out of every six males will be sexually assaulted. There continues to be multiple myths that support the non-reporting of male sexual assault that plague society.

Male sexual assault has a higher incidence of physical injury that ranges from 13-57% as compared to 10-37% in females. Males are more likely to be beaten than female sexual assault victims. More than 80% of male victims are heterosexual. One of the biggest fears from men after the sexual assault is that they really are homosexual because only gay men would get raped. Another barrier to reporting sexual assault is the high drug use in this population. Males do not want to report the rape because they also have been using drugs and do not wish to disclose this factor to law enforcement along with the report of sexual assault. Male victims are also young and may not be aware of services to help them.

This presentation will review other myths and reasons why males may not report sexual assault. Data collected from over 3,000 sexual assaults of both genders will be explored and discussed. This data will look at the ages of the male victims and race of males, who have reported sexual assault as well as the relationship to the perpetrator. Victim characteristics will also be explored from the data analysis.

Perpetrators are aware how erection and ejaculation confuse the male and they will frequently tell the victim they enjoyed it because they had an erection. They will discourage the male from reporting. This gives the perpetrator an increased sense of control in this crime.

Psychological impact also affects this population with a higher incidence of mental health issues such as depression requiring medication.

Barriers to health care, psychological issues and treatment will be discussed along with a review of current literature in the field of male sexual assault. Several case studies of medical findings in male sexual assault will be presented as well. Key points and best practices will be highlighted for application by attendees in their clinical settings.

Male Sexual Assault, Rape, Sexual Assault Database

D62 A Comprehensive Competency-Based Process for the Recruitment of Forensic Scientists

Jack Laird, MS, Johanne Almer, MS, Roger Frappier, MS, Andrew Greenfield, MS, Cecilia Hageman, PhD, and Jonathan Newman, BS, Center of Forensic Sciences, 25 Grosvenor Street, Toronto, Ontario M7A 2G8, Canada*

After attending this presentation, attendees will learn about progressive initiatives taken to strengthen the process of recruiting forensic biologists thereby ensuring the success of candidates with the skills and competencies most relevant to the position. The presentation will highlight aspects of the recruitment process including the evaluation and weighting of various components and will demonstrate how key competencies and technical skills are assessed through the selection process from the screening of applications to the job interview.

This presentation will impact the forensic community and/or humanity by demonstrating the use of effective tools and strategies to ensure the recruitment of appropriately qualified personnel into the forensic scientist position.

In the past 5 years, the Biology Section at Ontario's Centre of Forensic Sciences (CFS) has recruited over 30 biologists through annual competitions. The process, while aligned with Government of Ontario hiring standards, has evolved to a rigorous assessment of skills and competencies¹. The forensic biologist position is responsible for managing scientific examinations in criminal cases, and includes acting as a scientific advisor for clients, performing or overseeing the screening of evidence items for body fluids, interpreting and reporting the results of both body fluid and DNA results, and providing expert testimony when required.

Between 200 and 300 applications are received for each competition. Applicants are selected for scrutiny on the strength of their cover letter and CV, insofar as it is aligned with the key qualifications of the position outlined in the job advertisement. Short-listed candidates are further screened through the on-site administration of a two-hour invigilated technical examination, assessing the underlying theoretical knowledge required during the application of all aspects of body fluid and DNA analysis. Only the top performers are subsequently invited to interview – at least three candidates are interviewed for each available position.

The interview is comprised of multiple components, in the following sequence, lasting a total of 3 hours.

• **Panel questions:** A three-member panel asks a series of questions, requiring the candidate to demonstrate examples of key competencies through reference to past behavior. This component focuses less on technical knowledge than on behavioral competencies.

• **Candidate oral presentation - with supporting tools:** Candidates are asked to prepare a 10-minute, time-limited PowerPoint presentation summarizing the key messages from a published paper

concerning applicable research, sent to them a week ahead of time. This component establishes whether the candidate is capable of synthesizing a paper's technical content into a clear, concise, and effective presentation using a common software application. Candidates are also asked follow-up questions, dealing with the practical application of the paper's findings.

• **Candidate oral presentation – no supporting tools:** Candidates are sent a question regarding the field of forensic biology one week prior to the interview, and are asked to prepare a 10-minute, time-limited oral response with no visual aids or supporting notes. This component establishes whether the candidate is capable of researching the salient points required of the response and of conveying these effectively through clear, unassisted communication.

• **Mock case consultation role-play exercise:** The candidate is asked to play the role of a forensic biologist, and the interview panelists assume the roles of a regional supervising coroner, a police investigator, and a police forensic identification officer in the very early stages of a high-profile homicide investigation where the perpetrator remains at large. A case conference is held and in a dynamic and highly interactive process, the scientist is called upon to provide advice and guidance with respect to what scientific examinations may be undertaken. Additionally, the scientist is asked to prioritize the examinations and to commit to particular turnaround times, given immediate public safety concerns expressed by the police.

This component demonstrates the candidate's ability to establish and maintain focus in a high-pressure scenario, and to distil a large volume of information into a manageable and effective action plan that meets the needs of customers.

• **Court role-play exercise:** Candidates are provided with a brief case history, a sample of basic analytical data, and a report detailing basic forensic findings and conclusions. They are asked to adopt these materials as their own case file and are given 15 minutes to review them in preparation for a mock court.

During the mock court, the candidate is asked to 'take the stand' in their capacity as an expert witness, while members of the panel assume the roles of judge, crown attorney, and defense counsel.

This component assesses the technical substance of answers to scripted questions dealing with the significance of results and aspects of quality assurance, as well as their style, objectivity, clarity, and simplicity.

The elements described above provide a sound basis for critically evaluating a candidate's potential for fulfilling the demanding role of the forensic scientist. Each new competition involves different questions/scenarios, while consistently targeting the appropriate competencies. While many candidates will not have the requisite experience and training to immediately act at the level of the position which the selection process contemplates, it is nevertheless structured to identify those with the key competencies and the technical acumen that combine as the foundation for the development of an excellent forensic scientist.

¹ Jones, GP and S. Moore. 2001. A Behaviour Competency Model (BCM) for Forensic Scientists. Proceedings of the 53rd Annual Meeting of the AAFS, p. 130.

Forensic Scientist, Recruitment, Behavioral Competency

D63 The Need for Training in Forensic Science

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After attending this presentation, attendees will understand that the need for training and continuing education in forensic science is important for professional development.

This presentation will impact the forensic community and/or humanity by providing the forensic community with information about the need for training practitioners in the field of forensic science.

Training was identified as a significant area of need within the forensic science community in National Institute of Justice's (NIJ) *Forensic Sciences: Review of Status and Needs* (1999). Continuing education is important for professional development. It allows the forensic scientist to maintain and update specific knowledge and skills in methods, technology, and equipment.

In forensic science there is no standard for required training once employed. Several scientific and technical working groups recommend minimum mandatory contact hours of training for specific areas of forensics. Some accreditation and certificate programs have certain standards for training that the forensic scientist or laboratory have to maintain. Without mandatory training standards for all forensic scientists, some agencies and laboratories have established their own requirements regarding training. The legal and medical professions require continuing education in order to maintain their licenses to practice law or medicine. Both legal and medical professions must meet certain criteria of continuing education on an annual basis in order to continue working in their field.

Funding for training is at issue with most agencies' diminishing budgets. The recommended budget for training is 1-3% of the total laboratory budget which is on average \$1.3 million for publicly funded crime labs. Some labs have allotted \$1000-\$1500 per year for each person for training or continuing education. According to the Bureau of Justice Statistics (BJS), *Census of Publicly Funded Forensic Crime Laboratories* (2002), the budget for training is less than 1% of the overall laboratory budgets. Even when laboratories do have the funding for training, they lack the personnel to cover the person who is away for training. A few agencies see training as a reward to the scientist and not a need to continue his or her professional development. Worse, some view training as an opportunity for the employee to travel and have fun, not to improve their skills.

Job retention in forensic science is affected by training or the lack of. In some cases, agencies will expend time and resources to train a new employee but when the training is complete, the employee leaves for a position with better pay, benefits, or for personal reasons. Agencies which do not post entry-level positions exacerbate this problem. Conversely, the newly-hired analyst receives little to no training and leaves for a position that provides training.

There has been some assistance with funding for training. With award programs from the NIJ, the Forensic Resource Network (FRN) has provided free continuing education to the forensic science community. Workshops, short courses, symposia are offered to state and local forensic laboratories at little or no cost.

Training, Continuing Education, Standards

D64 Online Sexual Assault Examiner Training: Inaugural Venture in Forensic Education

Constance A. Hoyt, MSN, 49 Birch Meadow Road, Merrimac, MA 01860*

The goal of this presentation is to demonstrate the value of an online education and training program for the preparation of nurses and physicians who desire formal preparation in the performing a forensic sexual assault examination of either victims or suspects.

This presentation will impact the forensic community and/or humanity by sharing the author's experience in creating and teaching a distance learning forensic course to train sexual assault examiners.

This presentation will discuss the development of an online educational program for preparing sexual assault examiners and outline the value of the offering, as well as clinical training issues and problems associated with the non-traditional, online course.

In 2005, the University of California, Riverside (UCR) offered the first online course designed to prepare nurses and other licensed healthcare providers to perform the forensic examination and evidence collection associated with sexual assault victims or suspects. Since this was the initial attempt within the United States to train forensic sexual assault examiners through distance learning, considerable study was done to determine the feasibility of online programming and to identify teaching strategies which would ensure that the program's content and clinical experiences compared favorably to the traditional methods for preparing sexual assault forensic examiners. The intent of the online course was to prepare sexual assault examiners for under-served communities where suitable training courses do not exist, or hardships are imposed for full-time nurses who must incur lost wages and considerable expenses for travel and housing to obtain SANE-A training.

Didactic information and clinical internship experiences were based upon the curricular content of the International Association of Forensic Nurses for the SANE-A (Sexual Assault Nurse Examiner-Adult). Curricular materials of California, Massachusetts and other selected states with well-established training programs were also benchmarked to ensure that essential concepts and principles were included, and that those completing the course would be eligible for most existing certification opportunities. However, all students were encouraged to research local and state requirements prior to enrollment, to ensure their subsequent eligibility for certification examinations in their own practice locations since requirements vary widely.

A 60-hour didactic component included demographics and theoretic aspects of sexual assault as well as comprehensive assessment and evidence collection procedures. Photography, videography, acquisition of biological specimens, forensic wound identification and documentation, use of alternative light sources, and medicolegal requirements for evidence security and chain of custody procedures essential for subsequent legal proceedings for both victims and suspected perpetrators. Essentials of working collaboratively with law enforcement, judicial authorities, and social agencies were emphasized, as well as preparation for courtroom testimony related to the forensic examination. A follow-on internship for skill validation is arranged for each student who seeks to be certified as a sexual assault nurse examiner. Course instructors assist in linking participants with appropriate professional resources within their local community. UCR and its instructors maintain oversight throughout the internship to ensure integrity and proper validation of the clinical experiences. Experiences in the internship are carefully designed to ensure that students become well-versed on prevailing local or state statutes pertinent to sexual assault. Unique requirements of the crime lab within their respective practice jurisdiction are also addressed. There are planned interactions with law enforcement, prosecuting and defense attorneys, judges, victim advocacy representatives and other personnel who are involved in various aspects of sexual assault from prevention to long-term victim follow-up. Several opportunities for observations of court proceedings are offered, and other optional experiences may be designed to meet needs of individual students.

The online SANE-A course and its unique internship permit those in remote or rural regions of the United States or other countries to obtain this education and training, and to prepare for practice within the requirements and boundaries of their jurisdictions.

Distance Learning, Online Education, Sexual Assault

D65 Developing a Forensic Science Educators Conference

Julie A. Howe, MBA, and Mary Fran Ernst, BLS*, Saint Louis University, School of Medicine; Division of Forensic Pathology, 1402 S. Grand Blvd, St. Louis, MO 63104-1028*

The goal of this presentation is to provide attendees an overview of three Forensic Science Educators' Conferences given at Saint Louis University School of Medicine. An overview of each conference, teacher survey findings to assist planning of future conferences, and lessons learned from conducting each of the three conferences will be given. It will also offer suggestions as to how to plan and conduct such a conference in your locale.

This presentation will impact the forensic community and/or humanity by discussing how to plan a successful Forensic Science Educators Conference. Survey findings will be presented as to how each conference has helped teachers develop curriculum to incorporate forensics into their chemistry, biology, or science classrooms.

In December 2000, the Third International Mathematics and Science Study was released comparing US students with those of 43 other nations. By the end of the 12th grade, the performance of US students ranked among the very lowest in math and science of the 43 countries.

This startling statistic inspired the Forensic Science Educators' Conference (FSEC) concept which would take advantage of the popularity of forensic science to increase student's interest in science and math. FSECs are developed to provide teachers the background to enrich and/or develop challenging, innovative science and math curriculums for middle and high school students.

From July 24 to 26, 2006, the third Forensic Science Educators Conference (FSEC) was conducted at Saint Louis University School of Medicine. This conference was designed to be an advanced program, spotlighting emerging forensic disciplines.

After receiving a third \$50,000 grant from the Saigh Foundation of St. Louis to provide 69 full conference scholarships to middle and high school science and math teachers; a partnership between the AAFS, Saint Louis University School of Medicine and the Saigh Foundation was rekindled.

From the experiences gleaned from two previous FSEC's at Saint Louis University School of Medicine in 2002 and 2004; it was decided to introduce the teachers to new forensic science disciplines that they might be able to incorporate into their lesson plans.

The three-day program was developed and included: How to Teach Forensic Science, Trace Evidence, Polygraphy and the Courts, the CSI Effect, Fire Science and Explosions, Patterned Evidence, Analysis of Paints, Inks and Glitter, Available Forensic Resources from the National Clearing House for Science, Technology and the Law, Roles of Forensic Scientists in Mass Disasters, Digital and Multimedia Forensic Evidence, Forensic Nursing, Accident Reconstruction, Criminal Profiling, Forensic Medicine and a Teacher's Panel. Two hours of graduate credit was provided to attendees through Saint Louis University for only \$100.

This presentation will provide attendees an overview of the conference, teacher survey findings, and lessons learned from conducting three Forensic Science Educators Conferences. It will also offer suggestions as to how to plan and conduct a Forensic Science Educators' Conference in your locale.

Forensic Education, Forensic Science Educators Conference, Survey Findings

D66 Insect Evidence Distribution: Tabulation of Primary Indicator Species, the Life Stage, and the Season of Year Used in Final Analysis From 100 Random North American Cases

Neal H. Haskell, PhD, Forensic Entomology Investigations, 425 Kannal, Rensselaer, IN 47978*

The goal of this presentation is to determine which insect species and which of their life stages impact the entomological case analysis.

This presentation will impact the forensic community and/or humanity by determining if certain insect species are predominant, and if so, to concentrate limited research funding and effort on those identified species.

One hundred random cases were selected from case files numbering nearly 700 cases over a 25 year period. The cases selected were between 1996 and 2005 with approximately 10 per year being chosen (many of these cases went to court). Distribution of the cases covered all four seasons with 20 spring cases, 43 summer cases, 23 autumn cases, and 14 winter cases, thus accounting for the many different species of calliphorids (blow flies) found over the different seasons. Geographic distribution extended from Canada (Ontario) to the southern states and from the west coast to the east coast. The insect species used in the case analysis was the primary indicator species and its oldest life stage. This means that usually one species had the oldest life stage from which to base a developmental time postmortem interval estimate as opposed to a succession based estimate where combinations of insect species are found overlapping at different days postmortem. Of the 100 cases, 89 cases used Calliphoridae (blow flies) as the primary indicator species. Two additional cases used calliphorids in combination with other insect groups. Three cases employed the Black Soldier Fly (*Hermetia illucens*), with two using sarcophagid flies, and two cases using two muscid fly genera (*Fannia* and *Synthesiomyia*). One case used the Red Legged Ham Beetle, with only one non-time of death case employing the German cockroach to explain postmortem artifacts on the remains. The most common insect life stage used for analysis was the 3rd instar larva (this includes post feeding 3rds with 52 cases where these were the primary indicator stage). Puparia were figured in the analysis in 21 cases with 5 cases using adult blow fly species seasonal distribution. A total of five cases used 2nd instar larvae, nine cases with 1st instar larvae, and two cases with nearly hatched eggs. The overwhelming majority of the cases analyzed using insects was for determining time of death (only one in this set was not). The overwhelming primary indicator insect species was the blow fly group. The most used life stage was the 3rd instar larva. This forensic entomologist has been involved with and has seen many research studies spending great amounts of time, money, and other resources in attempting to determine what decomposition stage the carrion is in, or the insect succession when recording collecting and studying the progression of decomposition through to full skeletal remains. What is shown by this tabulation is that it is not the stage of decomposition that is of importance, but the insect life stage and how long it took at what temperatures to grow to that stage. The insects were being evaluated not the corpse. Also, not one of these 100 cases was founded on successional based postmortem interval estimation, but all (except the cockroach case) were based upon developmental based postmortem interval estimations. The successional based PMI requires thousands of hours of insect identification merely to obtain the data base needed for a specific geographic area of the world. If there is plenty of funding, research personnel, and taxonomists available, then research dealing with full succession models could be warranted. However, this is not the method being used in this case work. Therefore, forensic entomologists should concentrate primarily on the life cycles, geographic distribution, and growth and development of the most commonly used primary indicator species, the Calliphoridae (Blow Flies).

Blow Fly, Life Stage, Calliphoridae

D67 International Forensic Science Center: An Innovative Approach to Forensic Science Education for Students and Practitioners

James A. Bailey, PhD, Minnesota State University, 109 Morris Hall, Mankato, MN 56001; and Nizam Peerwani, MD, and Nannepaga Y. Zachariah, PhD, Tarrant County Medical Examiner, 200 Feliks Gwozdz Place, Fort Worth, TX 76104-4919*

After attending this presentation, attendees will be apprised of the development of an innovative educational opportunity for international students and practitioners interested in advancing their forensic science knowledge utilizing the Medical Examiner's office and local forensic science resources in Tarrant County, Texas.

This presentation will impact the forensic community and/or humanity by presenting a unique pedagogical approach to non traditional educational opportunities for international students and practitioners interested in enhancing their forensic science knowledge.

The presentation will discuss the development of an International Forensic Science Center that utilizes local resources and a nontraditional curriculum designed to educate international students interested in pursuing forensic science studies. The Chief Medical Examiner in Tarrant County, Texas is developing an innovative, three-month program designed for international forensic science students and practitioners. International students may come from a range of disciplines. Some of those disciplines may include the following: pathology, chemistry, toxicology, histology, and other medicolegal specialties. The International Forensic Science Center will oversee the governance of the program and it will be administered by the administrative hierarchy of the Tarrant County Medical Examiner's Office. A program coordinator will be assigned the responsibility of directing the program and its activities. The uniqueness of the program is comprised of a combination of mentoring, apprenticeship and individually designed programs for each student. Once an international student is accepted into the program, each student will meet with the coordinator and together, they will develop a specific curriculum based on the international student's forensic science interests and the Medical Examiner's caseload. International students seeking to gain experience in forensic science would have an opportunity to examine numerous case studies at the Center.

For example, the Tarrant County Medical Examiner's Office had 1,786 ME cases in 2004. Of those cases, 881 were from natural causes, 501 were accidental deaths, 224 were suicides, 127 were homicide, and 184 cases involved human identification. The international students will be assigned to study and observe in each of the sections; however, more time will be scheduled in areas of specific interest to the student. For example, the student will be assigned to observe and interact with the death scene investigators in the field and office, the evidence intake office, and the morgue where they will observe postmortem examinations. Additionally, each student will acquire experience in the following laboratories: forensic toxicology, forensic chemistry, forensic photography, histology, human identification, firearms, and latent prints. Students will gain experience with state-of-the-art laboratory instrumentation such as the scanning electron microscope (SEM), mass spectrometry, gas chromatography, and high-pressure liquid chromatography analysis. They will also become familiar with the automated fingerprint identification system (AFIS) while working in the latent prints laboratory. Each student will work closely with a mentor in each section to ensure a positive transition from one section to the next section. Moreover, each of the mentors will be assigned to instruct the students on the essential details, procedures, and protocols in their specific section.

In addition to the laboratories, there will be a breath alcohol testing section and a trace evidence section which analyzes hair, glass, paint, and fibers. Typically, the student will be assigned one day a week in five of the eight sections for a period of three months. As part of the educational process, the student will participate in weekly staff meetings in which cases will be discussed. Students will also participate in the weekly lecture seminars with other medical examiner staff and present at least once during the course of the program. There will be flexibility in the students' subject matter selection for presentations. Typically, presentations may include such areas as drug abuse, causes of death, child abuse investigation, and other similar medicolegal topics. International students with diverse backgrounds will have the opportunity to exchange ideas with the medical examiner's staff. In addition to the forensic science section assignments, international students will have an opportunity to attend related lectures at area institutions of higher learning. After successfully completing the program, the student will be awarded a certificate of completion by the Tarrant County Chief Medical Examiner.

Forensic Science, Forensic Education, Forensic Training

D68 Teaching a Crime Scene Practicum Using Multiple Cohorts

Melissa A. Connor, PhD, Dan Strydom, PhD, and Jody Meerdink, PhD, Forensic Science Program, Nebraska Wesleyan University, 5000 St. Paul Avenue, Lincoln, NE 68504*

After attending this presentation, attendees will understand (1) the objectives of teaching a crime scene practical course, (2) how to integrate student participation into the course in multiple roles, and (3) how to integrate the practicum into a forensic science curriculum.

Education in forensic science is becoming increasingly sophisticated. This presentation will impact the forensic community and/or humanity by presenting an educationally sophisticated method of integrating hands-on experience with classroom learning in a graduate forensic science curriculum.

To effectively reflect reality, a crime scene practicum must be designed to allow students to put into practice lessons learned from the classroom as well as integrating material from multiple disciplines. Students will work together as a team toward investigative goals that have been defined. The crime scene practicum developed by the Forensic Science Program at Nebraska Wesleyan University meets these goals by giving roles to each cohort going through the program. Students who are working on their master's research are assigned roles as "Faux Felons". These students, working with the faculty, design and create the scenes and work with second year students throughout the exercise. Each scene must include biological evidence, impression evidence, and evidence that reflects the behavior of the perpetrator. Students in the second year of the program investigate the scene and process the evidence. They must request reference samples for the evidence, reports from appropriate specialists (autopsy reports, odontology reports, etc.), interviews, and other information (provided by their felon), to work toward identifying a suspect and gathering enough evidence for an indictment or arrest warrant. Students in the first year of the program serve as jury members on the mock Grand Jury that ends the investigation and vote whether or not to indict each team's suspect.

Forensic Science Education, Crime Scene Practicum, Cohort Teaching



E1 Police Use of Force: Where Is the Line and When Is It Crossed?

J.C. Upshaw Downs, MD, Coastal Regional Medical Examiner, 925A Mohawk Street, Savannah, GA 31419; Michael M. Baden, MD*, 15 West 53rd Street, #18B-C, New York, NY 10019; William R. Oliver, MD*, Georgia Bureau of Investigation, Northwest Regional Crime Laboratory, 533 Underwood Drive, Summerville, GA 30753; Linda B. Kenney, JD*, 15 W 53rd Street, #18B-C, New York, NY 10019; and Timothy Cloutre*, Vermont State Police, Detective Sergeant, 1068 US Route 5, Suite 1, St. Johnsbury, VT 05819*

After attending this presentation, attendees will understand the scope and nature of controversies surrounding the death of subjects involved in police use of force situations and the thought processes used in forming cause and manner of death opinions.

This presentation will impact the forensic community and/or humanity by helping the forensic community to better understand the myriad levels of controversy regarding law enforcement use of force decisions. A logical approach to determining the cause and manner of death opinions will be presented, allowing practitioners to better understand future cases and the necessity of adequate evidence and specimen collection and testing.

Among the most highly emotionally charged situations in forensics arises in excessive use of force cases. The medical examiner sees the final outcome of the scenario, but such events are hardly static events. Law enforcement personnel must make literal life-or-death judgments in the blink of an eye. The sequela can last a lifetime, with the officer labeled a hero protecting the citizens or a rogue preying on the weak under color of law. These cases almost invariably end in the scrutiny of litigation, and all too often in potentially costly civil suits.

Utilizing a panel format, the authors will present a case-study approach on police use of force and death certification. Beginning with the basics of cause and manner of death, the authors will cover the spectrum of “less than lethal force” including electromechanical devices, pepper spray, etc. The classification of unintended deaths caused in whole or in part as homicide is other determinations of manner of death that may cause potential concern. The thought processes and logical paradigm utilized to form cause and manner of death will be discussed. In considering manner of death, the concept of “suicide by police” will be reviewed.

Particularly recently, the use of electric stun devices, has become an integral, but controversial (to some), tool involved in subdual of suspects. There has been discussion among medical professionals on the medical evidence of the role such devices play in deaths associated with police custody. A review of the literature and discussion of pertinent medical issues will be provided.

The police officer’s general mind set and duties will be presented by active law enforcement personnel. Special attention will be given to when the decision to use force (and how much to use) is made.

The question of how far is too far and when the civil and criminal legal standards have been breached will be addressed by counsel.

The presentation will culminate in a question and answer discussion with the panel.

Police, Force, Death

E2 Forensic DNA Evidence: Recent Controversies

William C. Thompson, PhD, JD, University of California, Irvine, Department of Criminology, Law & Society, Irvine, CA 92697; and Betty Layne DesPortes, JD*, Benjamin & DesPortes, PO Box 2464, Richmond, VA 23218-2464*

After attending this presentation, attendees will be familiar with some recent cases that have generated concerns about the proper analysis, characterization, and use of DNA evidence in the legal system. Reference to specific cases will be used to highlight the various areas in which the interpretation and presentation of DNA evidence can be affected by weaknesses in quality assurance programs, deficient training, and even political pressures.

This presentation will help the forensic community by inspiring discussion of: (1) best practices for quality control and quality assurance, (2) standards for characterizing the results of DNA testing for presentation in the courtroom, (3) proper argumentation about DNA evidence by trial lawyers, and (4) appropriate review of cases by appellate courts and scientific advisory panels.

As DNA analysis takes an ever-increasing prominence in the criminal justice system – both in identifying the guilty and in exonerating the innocent – the need for strict quality control measures has also increased. Instances of quality control lapses and other controversies in the analysis and presentation of DNA evidence have been reported even in laboratories long-regarded as “the best labs in the country.”

In the wake of several well-publicized laboratory scandals across the country, scientific oversight of crime laboratories has become an issue for state legislatures and government agencies. Some states have created separate agencies to provide scientific guidance and empowered to review allegations of misconduct or error. Whether these agencies are functioning as designed, however, remains an issue.

Another subject of much controversy is what corrective or remedial actions are necessary when quality control lapses or misinterpretation are discovered in crime laboratories. The proper role of accrediting agencies in auditing or reporting scientific protocol or interpretation lapses factors into this discussion.

After attending this presentation, attendees will be familiar with some recent cases that have generated concerns about the proper analysis, characterization and use of DNA evidence in the legal system. Reference to specific cases will be used to highlight the various areas in which the interpretation and presentation of DNA evidence can be affected by weaknesses in quality assurance programs, deficient training, and even political pressures.

This presentation will help the forensic community by inspiring discussion of: (1) best practices for quality control and quality assurance, (2) standards for characterizing the results of DNA testing for presentation in the courtroom, (3) proper argumentation about DNA evidence by trial lawyers, and (4) appropriate review of cases by appellate courts and scientific advisory panels.

Using recent cases as examples, the speakers will discuss issues that have recently generated controversy in the criminal justice system, focusing on how the initial test results were characterized in laboratory reports and later presented in court. Issues related to interpretation of low-level results and incomplete DNA profiles, use and interpretation of scientific controls, statistical characterization of results (including use and misuse of likelihood ratios), and argumentation by lawyers about the meaning and significance of test results will be discussed. The panelists will also discuss post-conviction test results, post-conviction destruction

of evidence, appellate review, and review of the results by scientific advisory panels. The discussion will reveal how controversy over DNA testing can arise even in a state that claims to be at the forefront of DNA testing. The primary focus, however, will be on the development of better practices and procedures that can reduce the likelihood of problems in any laboratory system and assure better use of results in any jurisdiction. The presentation is intended to emphasize the need to remain vigilant in maintaining the integrity of the forensic science community. If forensic evidence is not objectively tested, analyzed, and interpreted by adequately trained forensic scientists, the search for the truth will be compromised, if not defeated.

DNA, Legal, Interpretation

E3 Run-Specific Limits of Detection and Quantitation for STR-Based DNA Testing

Dan E. Krane, PhD, Wright State University, 3640 Colonel Glenn Highway, Biology, Dayton, OH 45435*

After attending this presentation, attendees will understand a new and objective means of distinguishing between signal and noise in DNA typing electropherograms.

This presentation will impact the forensic community by demonstrating that arbitrary minimum peak height thresholds can be replaced with objective and more sensitive limits of detection that will allow more reliable information to be extracted from DNA profiling electropherograms.

STR-based DNA profiling is an exceptionally sensitive analytical technique that is often used to obtain results at the very limits of its sensitivity. The challenge of reliably distinguishing between signal and noise in such situations is one that has been rigorously addressed in numerous other analytical disciplines. However, an inability to accurately determine the height of electropherogram baselines has caused forensic DNA profiling laboratories to utilize alternative approaches. Minimum thresholds established during laboratory validation studies have become the *de facto* standard for distinguishing between reliable signal and noise/technical artifacts.

The conservative nature of these commonly employed thresholds can also arbitrarily remove from consideration legitimate signal from trace and secondary contributors to an evidentiary sample – matters of critical importance in many criminal investigations. These minimum peak height thresholds also generally fail to consider variability in the sensitivity of instruments, reagents, and the skill of human analysts involved in the DNA profiling process over the course of time.

Software made publicly available by the National Center for Biotechnology Information now provides an alternative means of establishing limits of detection and quantitation that is more consistent with those employed in other analytical disciplines. The presenters have used that software to determine the height of each data collection point for each dye along a control sample's electropherogram trace. Those values were then used to determine a limit of detection (the average amount of background noise plus three standard deviations) and a limit of quantitation (the average amount of background noise plus ten standard deviations) for each control sample. Analyses of the electropherogram data associated with the positive, negative and reagent blank controls included in 50 different capillary electrophoresis runs validates that this approach could be employed to objectively determine run-specific thresholds for use in forensic DNA casework.

A known mixed DNA profile from two unrelated individuals of an approximately 10:1 ratio was also examined using this methodology and all alleles associated with the secondary contributor were found to be at or above the run's limit of detection yet were also below the testing laboratory's validated minimum peak height threshold of 100 relative fluorescent units.

Limit of Detection, Limit of Quantitation, DNA

* Presenting Author

E4 Empirical Analysis of the STR Profiles Resulting from Conceptual Mixtures

Dan E. Krane, PhD, Wright State University, 3640 Colonel Glenn Highway, Biology, Dayton, OH 45435*

After attending this presentation, attendees gain proficiency towards determining the number of contributors within a mixed DNA sample based on the maximum number of alleles observed at any given genotyped locus.

This presentation will impact the forensic community by demonstrating that analysts often underestimate the number of contributors within a mixed DNA sample and by illustrating steps for correcting that inaccuracy.

Samples containing DNA from two or more individuals can be difficult to interpret. Even ascertaining the number of contributors can be challenging and associated uncertainties can have dramatic effects on the interpretation of testing results. Using an FBI genotypes dataset, containing complete genotype information from the 13 Combined DNA Index System (CODIS) loci for 959 individuals, all possible mixtures (146,536,159) of three individuals were exhaustively and empirically computed. Allele sharing between pairs of individuals in the original dataset, a randomized dataset and datasets of generated cousins and siblings was evaluated as were the number of loci that were necessary to reliably deduce the number of contributors present in simulated mixtures of four or less contributors. The relatively small number of alleles detectable at most CODIS loci and the fact that some alleles are likely to be shared between individuals within a population can make the maximum number of different alleles observed at any tested loci an unreliable indicator of the maximum number of contributors to a mixed DNA sample. Peak heights and areas sometimes provide additional data that is useful for the purpose of mixture resolution but this information is not utilized in the analysis presented here.

Instead, this study examines the interpretation of STR data in cases where this information is unreliable (i.e. when degradation has occurred and/or stutter complicates interpretation), unavailable (i.e., only a laboratory's summary report is provided for review) or uninformative (i.e., the relative contributions by two or more contributors are similar). As a result, the study represents a worst-case analysis of mixture characterization. Within this dataset, approximately 3% of three-person mixtures would be mischaracterized as two-person mixtures and more than 70% of four-person mixtures would be mischaracterized as two- or three-person mixtures using only the maximum number of alleles observed at any tested locus.

We also assess the ramifications of invoking analyst discretion to discard a seemingly anomalous locus by determining the number of three-person genotype mixtures where discarding a single locus with the highest number of different observed alleles produces results consistent with mischaracterization of the mixture as a single source sample or as a two-person mixture. A larger amount of pair-wise allele sharing was observed between individuals in the original FBI dataset relative to five datasets of randomized individuals suggesting that the FBI dataset may contain some pairs of closely related individuals. The extent of allele sharing between siblings in large-scale simulations also suggests that perfect 13 locus matches (26 out of 26 possible alleles) occur at a frequency (an average of 3.0 per 459,361). This frequency suggests that some are likely to exist in large populations such as the general population of the United States and even eventually in DNA profile datasets that contain large numbers of close relatives.

DNA, Mixture, Bioinformatics

E5 Assessing the Implications for Close Relatives in the Event of Similar But Non-Matching DNA Profiles

Dan E. Krane, PhD, Wright State University, 3640 Colonel Glenn Highway, Biology, Dayton, OH 45435*

After attending this presentation, attendees will understand the application of objective criteria to determine if a relative of an individual with a similar but non-matching DNA profile may have been the contributor of that similar sample.

This presentation will impact the forensic community by demonstrating a significant potential for increase in the number of investigations solved as a result of database searches.

One of the principle advantages of using STR genotypes for the purposes of human identification is their amenability to archiving in searchable databases such as the Combined DNA Index System (CODIS). More than two million complete, 13 locus STR-DNA profiles of convicted offenders have already been entered into the CODIS database in the United States and similar databases are maintained by European countries and Australia. These databases were created as investigative tools for law enforcement agencies tasked with identifying suspects in cases where a perpetrator has left biological material at the scene of a crime but few or no additional leads are available.

A perfect match between the STR DNA profile of an evidence sample and an individual whose genotype is maintained in a database of convicted offenders has clear utility as an investigative tool. Lack of concordance between the alleles of an evidence sample and an individual's DNA profile is also commonly used as an investigative tool in that the individual can be excluded as a source of the biological material in the evidence sample.

However, since the alleles associated with STR loci are inherited in a strictly Mendelian fashion, it is possible that the most likely explanation for a nearly perfect match is that the source of an evidence sample is a close relative of the individual whose DNA profile is available for comparison. While this information may prove to be very useful to law enforcement investigators, relatively little has been done to establish what level and kind of similarity between evidence and non-matching database profiles are sufficient to justify investigation of an individual's relatives.

Policies regarding familial searches within the United States vary widely. Using both the number and rarity of matching alleles, a general framework for determining the relative likelihood that an individual's close relative (e.g. a sibling, parent, or child) is the source of an imperfectly matching DNA profile is described. Also described are the results of simulations that provide statistical boundaries on both the number and rarity of the alleles shared between an evidence sample and an excluded suspect necessary to determine if a significant shadow of suspicion is cast upon the excluded suspect's relatives. It is not possible to arrive at a single metric such as "number of shared alleles" that is independent of allele frequencies, the number of initial suspects considered and the number of potential alternative suspects for the purposes of determining that the investigation of a sibling is warranted. Two important parameters, the size of the reasonable alternative suspect pool and the tolerance for false positives/negatives, are beyond the scope of forensic scientists and are left to be determined on a jurisdictional (and even case-by-case) basis.

Familial Search, DNA, Partial Match

E6 Gunshot Residue: Is It Suitable for Court?

Patrick J. Sullivan, JD, Hennepin County Public Defender, 317 Second Avenue South, Suite 200, Minneapolis, MN 55401; and John W. Kilty, BS, Forensic Science Consultant, 13102 Jingle Lane, Silver Spring, MD 20906*

After attending this presentation, attendees will have information regarding whether the results of testing for gunshot residue should be submitted as evidence in court as well as why a judge recently excluded GSR evidence under the *Frye* test.

This presentation will impact the forensic community and/or humanity by demonstrating whether scientific testing exists to provide information that will be helpful for court and police or are private laboratories simply for profit businesses thereby limiting GSR as an investigative tool.

Recently the FBI Laboratory stopped doing GSR testing, citing the allocation of scarce resources. Newspapers reported that the FBI found GSR particles in pertinent areas in their new state of the art \$130,000 000 laboratory. During the past year the FBI hosted a meeting on the future of GSR. Only employees of laboratories which actually do GSR testing were invited to attend. Discussions and minutes were not disclosed until oral reports were given months later to limited audiences at two scientific meetings. A written report was published online in the July 2006, issue of Forensic Science Communications. It was against this background that a legal challenge was mounted in a criminal case in Anoka County, Minnesota. Two people were shot and killed outside a pool hall. A number of people were stopped leaving the scene. They were brought to a police station and held together in a small hallway. Thirteen people were handcuffed on benches and on the floor. Police required all to use the bathroom and wash their hands. The police removed and replaced handcuffs after each person washed. Four hours later, sampling began. The subjects were taken into the test room one at a time still wearing clothes from the scene. They changed into jail clothes in the test room. Their hands were photographed using a table as a backdrop and the table was wiped off between subjects with a dry towel. Twenty-four "stubs" were sent to a commercial analytical laboratory for testing using SEM. A note stating that the subjects may have washed their hands was included. The stubs were all tested at a cost of \$4800. All tested positive to a degree. The report, which was given to the grand jury, stated that positive test results meant that the subject had fired a gun, been in close proximity when a gun was fired, or handled contaminated guns or ammunition. The analyst testified at the *Frye* hearing that the language in the report was a mistake. He added the language "or other surfaces" to his testimony. The court ruled that GSR testing was not generally accepted in the scientific community of GSR experts (in part because there is no standard as to the number of particles needed), that it was not reliable in this case, and that it would not be helpful to the jury. The state is not appealing but has asked the Court to reconsider as to only one Defendant. Why? Because he had so much residue that it must not be contamination. They stated that they needed it to show that the Defendant fired a gun or was near a gun when it was fired - exactly what was in the original discredited report. It was very clear from the testimony at the hearing that the evidence was being offered by the State and the State's expert to show much more than it can really show. That expert has testified to much more in the other cases. The Court's ruling in this case came before the publication of the GSR Symposium Report and the report raises many questions including acceptance criteria, report language, criteria for a positive test, and quality control in the laboratories doing GSR analysis.

Gunshot Residue (GSR), Frye, Contamination

E7 A Case of Propoxyphene Overdose: Accident, Suicide, or Homicide

Douglas H. Posey, Jr., MD, Georgia Bureau of Investigation, 3121 Panthersville Road, Division of Forensic Science, Decatur, GA 30027*

After attending this presentation, attendees will become familiar with some of the pitfalls of postmortem drug level interpretations and some of the ethical hurdles encountered in determining cause of death.

This presentation will impact the forensic community and/or humanity by providing a chance to revisit the issues of living wills and the ethics involved in “pulling the plug” on the respirator.

The decedent was a 39-year-old man who was working as a manager for a private corporation when he suffered a severe back injury as the result of a workplace accident. He was rendered a paraplegic as a result of the accident, though he was able to ambulate through the use of leg braces and canes. He was married to a registered nurse at the time of his death.

The decedent became totally paralyzed after undergoing a fifth surgery to correct chronic back pain and at the time of his death the post-surgical medications included Percocet, flurazepam, diazepam, and Propoxyphene. A female nursing assistant was hired from a local healthcare agency to provide in-home nursing care for approximately one hour per day. She was discharged following an alleged romantic encounter and seduction. The therapeutic regime soon led to opiate dependency, and the wife reported that prior to his demise the decedent was taking 5 to 8 of the propoxyphene pills per dose on an every 4 hour schedule. He had become opiate dependent, reportedly suffered remorse following the seduction and marital discord developed. There was a suspicion of alcohol use the night prior to his demise (hospital lab reports alcohol at 17mg/dl). According to reports from the scene, multiple empty medication containers were present when he was eventually found unresponsive by his wife twelve months after his last surgery. He was unresponsive when evaluated by the emergency medical services and was subsequently transported to the local hospital along with the empty pill containers. According to the medical record, as he was taken to the emergency room his wife went to the admissions office to complete the necessary paperwork to have him admitted to the hospital. In the emergency room, he was treated by a board certified emergency medical physician, was intubated and admitted to the Intensive Care Unit. A neurological follow up was recommended as part of his continuing care. When his wife arrived in the Intensive Care Unit she insisted her husband did not want to be intubated in compliance with his living will.

After a brief discussion detailing the consequences of extubation and her husband’s imminent demise following extubation, the nurse received a telephone order from the physician of record to extubate the patient. She extubated him and pronounced him dead a few minutes later. The medical record list the principal diagnosis as Respiratory failure with a secondary diagnosis of multidrug overdose. The decedent had a toxicological autopsy performed at the medical examiner’s office and “subclavian” blood revealed a “large” amount of propoxyphene and norpropoxyphene, as well as several other drugs in lesser amounts. The cause of death listed by the coroner was multiple drug overdose and the manner of death was accidental.

Several questions surrounding the death of the decedent remain unanswered. His blood contained no flurazepam, yet an empty flurazepam bottle was found at the scene. His blood contained alcohol, but the source of that alcohol was never explained. His arms contained needle marks, yet his medications were all taken orally. Most importantly, the number of propoxyphene tablets remaining in his prescription bottle would suggest that he was taking impressive 40-45 pills per day, a number confirmed by the decedent’s wife with no other validation.

This presentation will look at a number of interesting aspects of this case, including discrepancies in the toxicological findings, the over-

interpretation of those findings by qualified experts, questions about the sequence of events given by the wife, unexplained findings from the postmortem examination, and ethical questions about the removal of life support.

Propoxyphene, Suicide, Homicide

E8 Eyewitness Identification: Recent Developments in the Science & Policies

Sheri H. Mecklenburg, JD, Chicago Police Department, 3510 South Michigan Avenue, Chicago, IL 60653*

After attending this presentation, attendees will learn how the science of eyewitness identification applied to the first field study of those principals on eyewitness identification.

Researchers, policy makers, and the criminal justice system have long debated the value of eyewitness identification and how to make such identifications more reliable. Researchers believed that the solution was here, found in the academic research. In the first field study to test these principles, the forensic community can see how this research applied in the real world. This presentation will impact the forensic community and/or humanity by demonstrating how the Illinois Pilot Program was a ground-breaking study on eyewitness identification, and its results should be discussed, analyzed and reviewed for their continuing impact on the field of eyewitness identification.

The presenter is the director of the Illinois field study on eyewitness identification, the first field study to examine eyewitness identification procedures in hundreds of lineups involving real crimes, real victims, real witnesses and real suspects. The Illinois pilot program, a year-long study of both photo and live lineup procedures from three different-size law enforcement agencies, grew out recommendations made to address wrongful convictions. The Illinois study is the first field study to collect data on recommended reforms according to the scientific protocol, the first field study to concurrently collect data for comparative purposes on traditional lineups and the first field study to offer a comparative analysis. Two nationally-renowned experts analyzed the data independently.

The acceptance of DNA evidence by the judiciary revolutionized the criminal justice system, allowing police and prosecutors to determine with certainty the guilt or innocence of suspects in crimes where the offender left behind probative biological evidence, such as those involving sexual assault. The acceptance of DNA also opened the door to exoneration for the innocent who had been wrongfully convicted prior to the availability of DNA. The first wave of these DNA exonerations shook the faith in and foundations of the criminal justice system, leaving law makers, lawyers and law enforcement to search for the answers to what had gone awry and to seek safeguards to prevent such miscarriages of justice in the future. In attempting to learn lessons from these DNA exonerations, mistaken eyewitness identification emerged as one of the most common contributing factors to wrongful convictions.

Since the role of mistaken eyewitness identifications in wrongful convictions came to light, the way in which eyewitness identification is obtained by law enforcement has been called into question. Some answers have been offered, by what has been characterized as the “science” of eyewitness identification, which is based upon experimental research studies of eyewitness identification procedures by social scientists. This body of science has offered, among other things, proposed instructions, proposed standards for picking participants for the lineups and what is referred to as “the sequential, double-blind eyewitness procedure” for lineups. Though the protocols for the sequential double-blind procedure are not yet standardized, this method generally involves showing photos or participants one at a time rather than side-by-side, with the witness required to make a decision on each photo or person before viewing the next one. The “double-blind”

component requires that the lineup be conducted by an administrator who does not know which photo or live participant is the suspect and which are the fillers or “foils.”

Although the National Institute of Justice recommended field studies on this aspect, as well as other proposals from the social scientists in 1999, only recently have field studies been touted, with Illinois being the first of its kind. The findings of the Illinois study will surprise you. The response to the study also may surprise you. However you view the Illinois study, two questions relevant to all scientists cannot be ignored: (1) to what scientific standards the science of eyewitness identification in this post-DNA world be held; and (2) to what extent has politics have influenced the science of eyewitness identification? The presenter will discuss the findings of the Illinois study, address the criticisms and make recommendations for the future of eyewitness identification.

Eyewitness Identification, Science, Field Testing

E9 Digital Imaging Technology and Its Application in Court

Thomas L. Martin, Crime Scene Forensics, LLC, PO Box 515, Red Hook, NY 12571*

After attending this presentation, attendees will understand the basic workings of digital images, how digital images are produced, and how they can be manipulated. Attendees will further understand some of the various ways that digital images can be used in court presentations.

This presentation will impact the forensic community and/or humanity by serving as a guide to the availability of various uses of digital imaging. It will provide attendees with a general understanding of digital imaging techniques, and its practical application to forensic science.

When digital imaging technology was first introduced, the initial reaction among courts and law enforcement agencies was one of skepticism. It was believed that this technology had no place in a court of law because images could easily be manipulated, and would not show a true and accurate representation of the subject photographed. Digital imaging technology should not be held synonymous with photo alterations, but rather with photograph improvements, and enhancements. There are numerous ways that digital imaging can provide valuable demonstrative evidence in court. This presentation will focus on the positive aspects of digital imaging technology. There will be demonstrations in photo enhancements; case studies will be presented in which digital imaging technology provided valuable demonstrative evidence in court, and explanations will be given in recording changes to digital photographs, in order to maintain their integrity. This presentation will provide attendees with a general understanding of digital imaging techniques, and their practical application to forensic science.

Forensic Evidence, Digital Imaging, Technology

E10 International Implications of Phishing Schemes: High-Tech Identity Theft

John D. Saba, Jr., JD, Office of the Attorney General of Texas, 3005 University Avenue, Austin, TX 78705; and Paul L. Singer, JD*, Office of the Attorney General of Texas, 300 West 15th Street, Austin, TX 78701*

After attending this presentation, attendees will understand the concept of a phishing scheme, the illusiveness of conducting the scam, and the limitations in battling the crime both for law enforcement and electronic forensic investigators.

This presentation will impact the forensic community and/or humanity by discussing how the scams are created and executed. Furthermore, this presentation will identify the electronic data needed to resolve the identity of the perpetrator. Finally, this presentation will discuss the ideal collaborative environment necessary for battling these crimes.

The basic phishing scheme has evolved due to the prevalence of malicious software on the Internet. Traditionally, phishing schemes were not so involved. The perpetrator would post a fake web site mimicking an actual web site (e.g., a large well-known financial institution), send phishing e-mail messages out to consumers, and then, more-times-than-not, store and collect personally identifiable information on the actual phishing web site, either to collect and use him or sell on the “e-black market.” Under more advanced phishing schemes, the end result is reached with greater ease and near-complete anonymity due to the prevalence of electronic “proxies” and malicious software available on the net.

A typical modern-day phishing scheme will be presented, a) noting how one creates and executes the scheme, b) identifying how one approaches solving the phishing scheme, and c) discussing the practical barriers of battling the phishing scheme.

Phishing Scams, Identity Theft, Cyber Crime

E11 Rehabilitating Juvenile Delinquents — The Texas Youth Commission Resocialization© Program

Kaci S. Singer, JD, Texas Youth Commission, 4900 North Lamar Blvd., PO Box 4260, Austin, TX 78765*

After attending this presentation, attendees will understand the principles and processes of rehabilitation used by the Texas Youth Commission (TYC) in treating delinquent juveniles and preparing them to reenter society as productive citizens.

This presentation will impact the forensic community and/or humanity by enhancing public and professional awareness of the TYC Resocialization© program, a rehabilitation program that is used in several states and countries in an effort to change juvenile behavioral patterns.

In the adult system, those convicted of a crime are required to serve their sentence before being released. Texas has developed a system for juveniles that require them to complete a rehabilitation program in which they focus on their negative behaviors and learn skills to avoid those behaviors in the future. The program requires youths to focus on their offenses and the ways they have victimized other people. They learn to identify thinking errors commonly used to justify behavior. They are able to identify barriers to their success and learn skills for coping with those barriers.

The presentation will provide an overview of the TYC Resocialization© program. Those attending will learn common thinking errors all persons use. The presentation will include information about other countries that currently use the TYC Resocialization© program in their juvenile justice system. Anecdotal stories will be used to demonstrate the effectiveness of the program.

This presentation will impact the forensic community and/or humanity by enhancing public and professional awareness of the TYC Resocialization© program, a rehabilitation program that is used in several states and countries in an effort to change juvenile behavioral patterns.

Juvenile, Rehabilitation, Delinquency

E12 An Introduction to the AJS Institute of Forensic Science and Public Policy and the AJS Commission on Forensic Science and Public Policy

Matthew S. Epstein, JD, LLM, AJS Institute of Forensic Science and Public Policy, 101 West Friendly Avenue, Suite 100, Greensboro, NC 27401*

After attending this presentation, attendees will learn about the work of the Institute of Forensic Science and Public Policy.

This presentation will impact the forensic community and/or humanity by eliciting ideas for collaboration between the forensic community and the Institute.

Introduction: The American Judicature Society was created in 1913 in response to considerable popular dissatisfaction with the justice system. From the beginning AJS has included members of the public, and especially non-legal professionals, in its work to build public trust and confidence in the way justice is administered on the national, state, and local level.

AJS has been central to many of the major reforms in judicial administration witnessed during the past 90 years. It shares in the credit for such developments as trial court unification; merit selection of judges employing nonpartisan nominating commissions; the establishment of a uniform set of rules of trial court procedure; the creation of judicial conduct organizations to enforce rules of judicial ethics; designing methods to address the ever-increasing number of cases in which one or both parties are unrepresented by counsel; and retooling the American jury to preserve its value and effectiveness in Determining the facts in today's world of increasingly complex litigation.

AJS's accomplishments are attributable to a few basic ingredients. AJS is non-partisan. AJS takes no position on substantive legal issues, but instead works to make sure that the process of adjudication is and appears to be fair and reliable. AJS is inclusive and transparent. AJS insists that its recommendations for reform rest on independent, objective research of the highest quality.

During the past 10 years, the advent of DNA evidence has proven that the justice system has wrongfully convicted too many citizens. Today there is no debate among reasonable people about whether there are wrongful convictions. Better informed questions are being asked, such as what can be done to guard against wrongful convictions in the future so that innocent people are not prosecuted and the guilty left free.

The AJS Institute of Forensic Science and Public Policy: Under the rubric of improving the truth-finding function of the justice system, AJS has established a multidisciplinary institute that will engage in empirical research and education relating to the scientific evaluation of fact issues arising in the criminal justice system. The Institute is an entity of the American Judicature Society, an independent, national and non-partisan organization of judges, lawyers and other members of the public. The Institute will offer research, educational, publication and consultation opportunities, as well as staff positions to scholars and students in North Carolina and elsewhere.

Intended areas of research and study include best practices for forensic crime laboratories; best practices in collection and preservation of eyewitness identification; best practices for interviewing suspects and witnesses; how to improve the reliability of polygraph examination results; and how to prevent confirmatory bias or tunnel vision in the investigations and prosecutions.

The AJS Commission on Forensic Science and Public Policy: The AJS Commission on Forensic Science and Public Policy has been established as the reviewing body of the research conducted by or directed by the Institute. The Commission is co-chaired by former Attorney General Janet Reno, former FBI Director William Webster, and

internationally recognized statistician and scientific expert Stephen Fienberg of Carnegie Mellon University. The Commission's honorary chair, Dr. Donald Kennedy, is president emeritus of Stanford University and editor in chief of *Science* magazine.

During its first retreat in April 2006, the Commission established five initial areas for the focus of its work: ensuring the preservation, scientific testing and access to evidence; improving the quality of eyewitness testimony; promulgating standards for, and the systematic evaluation of the nation's forensic labs; encouraging research and evaluation of pattern recognition techniques associated with forensic evidence to help solve crimes; and developing mechanisms to improve science education for the legal profession.

The Commission includes 38 leading scientists, members of law enforcement, judges, prosecutors, defense attorneys, forensic practitioners, victims' rights advocates, and academics from around the country.

AJS, Commission , Institute

E13 Identification of Precursor, Intermediate, and Final Products Routinely Seized From Clandestine Drug Labs by FTIR-ATR Spectroscopy

Eric J. Bukowski, PhD, and Shannon M. Richard, MBA, Shimadzu Scientific Instruments, 7102 Riverwood Drive, Columbia, MD 21046*

After attending this presentation, attendees will learn how to select or implement scientific instrumentation software that will support and enhance their expert witness testimony.

This presentation will impact the forensic community and/or humanity by enlightening the forensic community of FDA regulated spectroscopy software that can enhance the quality of the analytical evidence presented in a court of law.

A bulletproof expert witness testimony requires more than thorough answer preparation and an established professional standing in the field. The basic foundation of forensic testimony relies on the quality of the analytical data that is presented. The quality of analytical findings can only be enhanced by using 21 CFR Part 11 compliant software. The United States Food and Drug Administration (FDA) has set forth these regulations (i.e., 21 CFR Part 11) and guidelines for the proper collection and storage of electronic records and data storage. The portion of these regulations that pertains to forensic testimony is the requirements for audit trail, security, and data integrity. Specifically, compliant software requires that all data collection, manipulation be assigned both user identification information and a time & date stamp. This poster will highlight the features of the regulations and how it pertains to enhancing the quality of forensic evidence presented in a court of law.

Expert Witness, Software, Spectroscopy

E14 State Practice in the Management and Allocation of Transboundary Ground Water Resources in North America

Gabriel Eckstein, JD, LLM, Texas Tech School of Law, 1802 Hartford Avenue, Lubbock, TX 79409; Amy Hardberger, JD, Environmental Defense, 44 East Avenue, Suite 304, Austin, TX 78701*

After attending this presentation, attendees will have a better understanding of the current situation regarding shared groundwater agreements with an emphasis on North America. The presentation will also discuss important similarities between local shared water

agreements that are important considerations in these types of agreements.

This presentation will impact the forensic community and/or humanity by alerting the community to the dearth of groundwater agreements. It will raise awareness of this issue by highlighting the importance of agreements and their necessity to avoid litigation.

Throughout the world, international and state borders divide ground water resources. Yet, ground water does not recognize such boundaries and flows freely without regard to overlying politics. This disregard for the political dimension, coupled with the growing global importance of water, can give rise to conflicts and disputes regarding the use, allocation, and preservation of the resource.

Use and management agreements are an efficient mechanism to share a transboundary water resource and, possibly, to prevent such conflicts. While very few international agreements actually address transboundary aquifers, these instruments are informative and can serve as bases or models for future arrangements. Such agreements can provide standards or guidelines on the rights and obligations that the "sharing" states possess. Documents may also include enforcement mechanisms such as dispute resolution mechanisms providing a valuable resource for other entities with similar issues hoping to implement regulations for allocation or protection.

This presentation reviews existing interstate and international ground water agreements in North America. These range from informal memoranda of understanding between bordering cities to international agreements involving nations. Although the agreements vary dramatically, commonalities exist. These include principles of cooperation, sharing of information, joint monitoring, scientific research of the water source, and public participation. In addition to these commonalities, the legal mechanisms employed by the parties will be discussed in an effort to better appreciate drafting and enforcement concerns. Furthermore, dissimilarities related to differences in geology, climate, local needs, and other unique factors will be considered. The presentation concludes with a discussion of the importance of regional agreements and the effectiveness of compacts tailored to local characteristics and circumstances.

Groundwater, Legal, Policy

E15 Effectively Challenging the Forensic Expert in Court: The Role of Deontology, Logic Systems, and Deconstruction

Chantal Ferraro, PhD, Anthropology Dept., C.W. Post Campus, Long Island University, Brookville, NY 11548; and O'Brian C. Smith, MD, and Teresa A. Campbell, MD, Conscience and Science in Medicine, PO Box 40208, Memphis, TN 38174-0208*

After attending this presentation, attendees will acquire an understanding of the multifactorial procedures for impeaching the credibility or weight of an opposing expert witness' testimony and avoiding the same pitfalls with their own.

This presentation will impact the forensic community and/or humanity by demonstrating how to become more effective at evaluating experts, their qualifications, reports, opinions, and value to the trial regardless of the side that has called the expert. This also bears directly upon the structure and theory of the case as opined by the jurist.

Practicing jurists frequently encounter experts intending to testify on a wide variety of scientific matters. Today's courtroom is open to many different types of experts from the "hard" sciences to those encompassing the entire scope of "soft" sciences with the extremes of

science at one end and art at the other. *Daubert*, or F.R.E. 702, is not a gatekeeper in preventing erroneous expert testimony. Although the diversity of subjects qualifying as a science may be large, the philosophical structures defining the scientific method are fundamental and universal, thus holding any so-called science to a common denominator for assessment of adherence to the scientific method. When these basic principles are applied to the expert's opinion, report or methodologies, the identification of error and fallacy are made more obvious. Beyond this, an experts' credibility also depends upon their integrity as portrayed not only in the ethical soundness and reasonableness of their opinions when compared to their peers, but the presentation of professional credentials in their Curriculum Vitae as well.

"Deontology" (from the Greek *deon*, duty) is the duty of drawing ethical conclusions from one's observations and actions and is something rarely discussed in American forensic literature, but widely so in Europe. There, it is referred to as a code governing the practices of medicine and other disciplines with the philosophy that the correctness of an action lies within itself and neither the outcome nor the consequences are of any influence. While it does not possess a legal authority, it does serve as a standard; there to guide the practices of the professional and the objectivity of their opinions. By virtue of its being a duty applied to the arts and sciences of medicine, it must by definition be a product of the application of the scientific method to arrive at valid conclusions. The recent movement towards Evidence-Based Medicine (EBM) by clinicians in North America is a step in this direction yet remains largely unaddressed in forensics, and its absence constitutes an inherent weakness when forming an opinion.

Scientific method is founded solely upon the objectivity of observations, the formation of hypotheses to explain the observation followed by valid objective testing to support, deny or refine the hypothesis. From this evolved a logic system based upon deductive reasoning and tested by the syllogism: which is a true major premise and a true minor premise leading to a valid conclusion regarding a specific object or issue. By contrast is the influence of inductive reasoning, based upon intuition or unsubstantiated dogmatic teachings. There are also a series of errors in thinking as a consequence of the failure to properly apply the syllogism, resulting in fallacies of logic. Identifying these in court can be devastating to the witness's credibility

The critical evaluation of a forensic expert by a jurist is vital to controlling what is said and what is challenged in open court, regardless if the expert is one of yours, or comes from the opposing side. It employs additional formal techniques from Europe, based upon "text analysis" and "deconstruction" these are concise descriptions of what often happens in preparing for a case, but by virtue of its discipline, provides a format that promotes thoroughness of research and identifies strengths, weaknesses and helps sculpt strategies.

Deconstruction is designed to take something apart down to the level where it no longer makes sense. The object, be it a curriculum vitae, a report of analysis or an opinion is not destroyed, rather it is disassembled into components, giving insight as to how it was built initially. This in turn gives access to how the author thinks. This is also where text analysis enters, for the meaning of a sentence may vary from writer to reader, and the sequence of the sentence may give insight as to its weight in the opinion of the writer. This can open up alternative, or even opposing explanations the expert must then attempt to clarify or defend in open court. Applied to the curriculum vitae, deconstruction leaves no stone unturned in the vetting of each claim of expertise, case load, employment, training, faculty and other appointments, publications and previous court experience.

The explanation and demonstration of the above will be through illustrative case studies.

Jurisprudence, *Daubert*, Forensic Science

E16 *State v. Acme Manufacturing Company* — A Demonstration *Daubert* Hearing

David G. Ries, JD*, Thorp Reed & Armstrong, LLP, One Oxford Centre, 301 Grant Street, 14th Floor, Pittsburgh, PA 15219; Neal H. Weinfield, JD*, Greenberg Traurig, LLP, 77 West Wacker Drive, Suite 2500, Chicago, IL 60601; and James H. Clarke, PhD*, Vanderbilt University, 1408 Franklin Road, Brentwood, TN 37027

After attending this presentation, attendees will gain a practical understanding of what happens in a *Daubert* hearing. This will be an actual demonstration, with an expert witness, an attorney offering his testimony and an attorney opposing it.

This presentation will impact the forensic community and/or humanity by providing a better understanding of what happens in a *Daubert* hearing and the gatekeeping process which judges apply.

This is a demonstration *Daubert* hearing in a Natural Resources Damages action by the State against Acme Manufacturing Company, based on trichloroethylene (TCE) contamination of groundwater.

Acme operated a manufacturing plant on the site from the 1920s until the 1990s. TCE was used until the late 1980s for cleaning of metals. Until the late 1970s, waste TCE was disposed of in unlined lagoons or dumped “on the back 40,” both in accordance with standard industry practice for the time. After RCRA was enacted and the RCRA regulations were adopted, TCE was disposed of offsite. Until the plant stopped using TCE in the late 1980s, there were periodic TCE leaks and spills.

Soil on the site is contaminated with TCE. The groundwater under the site and to the east of the site is contaminated with TCE. Groundwater flows generally to the east. Acme is conducting remediation under CERCLA and RCRA under a Consent Order with the EPA. The Consent Order sets a cleanup level for TCE in groundwater of 5 ppb, the federal Maximum Contaminant Level (MCL) for drinking water. Acme’s consultant, Deminimus Environmental, has prepared a remedial plan which has been approved by EPA. The remedy includes an iron filings wall to the east of the site. The remedy is expected to take ten to fifteen years to reach the 5 ppb level outside the iron filings wall through natural attenuation.

In this separate court action, the State is seeking Natural Resource Damages for lost use of the groundwater until remediation is complete. The State does not have its own MCL for TCE and it disagrees with the federal level because it does not provide adequate protection.

Dr. Drow is the State’s proposed expert witness on hydrogeology. He is offering opinions on the volume of groundwater loss. His proposed testimony includes the opinion that the safe level of TCE in groundwater is 1 ppb which is the Method Detection Limit. His volume calculations are based on this 1 ppb level. As a fallback, he has also made calculations based on 3 ppb which is the Practical Quantification Limit for TCE.

Acme has filed a *Daubert* motion challenging Dr. Drow’s proposed testimony.

Daubert, Expert Testimony, Admissibility of Opinions

E17 Gateway of Opportunity for the Conviction of the Wrongfully Accused

Chantal Ferraro, PhD, Anthropology Dept., C.W. Post Campus, Long Island University, Brookville, NY 11548; and O’Brian C. Smith, MD*, and Teresa A. Campbell, MD, Conscience and Science in Medicine, PO Box 40208, Memphis, TN 38174-0208

After attending this presentation, attendees will have the ability to identify multiple sources of significant errors in expert testimony despite the scientific methodologies typically accepted by the courts.

This presentation will impact the forensic community and/or humanity by demonstrating the ability to identify fallacies of logic and various errors of practice commonly encountered in the testimony of experts.

The *Frye* test and now the *Daubert* standards are evolving tools designed to ensure the sciences and expert opinions presented in court are truthful, accurate, accepted by the scientific community and are stated by persons qualified to truly know what they are testifying about. Despite meeting evidentiary requirements, inappropriate evidence may be admitted with devastating effects.

The risk of admitting erroneous science has many sources: systemic, cultural, and human. Systemic errors arise from the lack of applying the scientific method to problem solving. Over-reliance upon artful inductive reasoning more than scientific deductive reasoning is compounded when an absence of guidelines or protocols exist. Quality assurance and quality review are not yet universally accepted tools. Forensic scientists do not monitor themselves or correct the misinformed and inexperienced. Cultural practices are reflections of organizational influences; some investigative agencies compartmentalize scientists who perform tests without context, others keep the scientists fully informed. Some agencies use a “supervising” scientist to testify, instead of the scientist performing the procedure. Differences in culture or competencies among agencies may create rivalries or rifts impairing cooperation and communication. Human factors include the decision, skill-based and perception-based errors of individuals. Hopefully, their opinion is formed in the absence of such errors, but is there documentation to assure that? Human factors also reflect resource management and supervision of the investigation. How well do investigators communicate among themselves and their scientists? Can members of a multi-agency “task force” become sufficiently familiar with each other to use communication tools (statements vs. summaries) in common?

This unseen environment is permissive; prosecutors are susceptible to using errors of science because they work with whatever they have been handed. Not being scientists and expecting *Daubert* to be followed may produce a mindset where the possibility of being misled accidentally, much less deliberately rarely occurs to the attorneys involved. Anxious, since forensic science crime shows became so popular, for the most scientific support of their argument, the opportunity exists for attractive yet erroneous science to enter the courtroom. Under the current rules of evidence it becomes the burden of the defense to either challenge everything under *Daubert*, compromise or fail to challenge because the discovery “looks OK” or seek to identify potential discrepancies in the science. This latter is often difficult since the worksheets capable of revealing this are not readily discoverable.

Sources of error with some examples for presentation:

- Loss of objectivity: sentimentalism destroys emotional balance (child cases, sexual assault).
- Science removed from reality: an inverted pyramid of logic (Descartes, 1596-1650).
- Misinformed: reliance upon an incomplete fact basis.
- Dogma: reliance upon tradition, “father to son” science as in exploding heads.
- Myth: hypothesis appealing to emotionality as in rule-of-three theory in child deaths.
- Absence of scientific method: intuitive reasoning, not deductive, rejection of coincidence.
- Idolatry: new “sciences” profilers, cadaver/anthrax dogs, facial recognition.
- Inappropriate expertise: over-reaching from one discipline to another.
- False Authority: documented expertise in one area is not conferred with administrative authority over other areas.
- Misplaced confidence: assumptions that scientific guidelines have been followed.

Jurisprudence, *Daubert*, Forensic Expert

E18 Terrorism and Police Policy in the 21st Century: Are We Ready for Suicide Bombers?

Sheri H. Mecklenburg, JD, Chicago Police Department, 3510 South Michigan Avenue, Chicago, IL 60653*

After attending this presentation, attendees will understand the problems that local law enforcement faces in confronting suicide bombers, rooted in traditional notions of deadly force, First Amendment rights, search & seizure and racial profiling.

This presentation will impact the forensic community and/or humanity by demonstrating how the forensic community must begin to think about the impact of suicide bombers expanding into the Western World and how is this threat going to be addressed in light of today's laws and policing policies.

This presentation will address the threat of suicide bombers in the United States from a local law enforcement perspective, including how local law enforcement's current training, policies and thinking will have to be adapted in order to prevent and confront suicide bombers on U.S. soil in the future. Although suicide bombers appear to be a tactic common to another part of the world, there is some recent history of suicide bombers in the Western World, as well as indications that a future of suicide bombers on U.S. soil may be inevitable. Suicide bombers are often categorized as a terror threat to be dealt with by the federal government, but the history shows that local law enforcement is most likely to be at the forefront of addressing the threat of suicide bombers in the future. There is much to be learned from the suicide bomber incidents which already have confronted local law enforcement, both here and abroad. This presentation will review how local law enforcement will have to address that threat and how local law enforcement's current policies and the applicable law compares with the best way to detect, confront and respond to suicide bombers. The presentation will discuss how the current use of deadly force policies followed by most local law enforcement in the United States are likely to make the confrontation with a suicide bomber more dangerous. The presentation will discuss how new policies and, particularly, training on deadly force will have to be developed for confronting suicide bombers and how these policies and training will be influenced by public acceptance and politics. The presentation also will discuss how local law enforcement policies on intelligence gathering, First Amendment rights, search & seizure and racial profiling may have to be adapted to address the threat of suicide bombers, but any necessary adaptations may be inhibited by local politics and community acceptance. The presentation will review the lessons learned for local law enforcement from the Madrid and London suicide bombing incidents. Finally, the presentation will propose policy changes that local law enforcement must make to successfully address the threat of suicide bombers.

Police, Law, Suicide Bombers

E19 Custody Deaths in Northern New Jersey — A Five Year Review

Zhongxue Hua, MD, PhD, J. Shaikh, MD, N. Mambo, MD, A. Zhang, MD, T. Blumenfeld, MD, J. Amolat, MD, E. Lilavois, MD, G. Jackson, PhD, L. Perez, MD, C. Blanchard, MD, and G. Hart, MS, Regional Medical Examiner's Office, 325 Norfolk Street, Newark, NJ 07103*

After attending this presentation, medical examiners/coroners, medico-legal investigators, and other forensic practitioners will learn the cause and the manner of custody deaths examined at the Regional Medical Examiner's Office in Newark, New Jersey. A high percentage (28%) of non-natural manners of death during custody was reported.

This presentation will impact the forensic community and/or humanity by discussing the results of a study that revealed a significant percentage (28%) of custody deaths were due to non-natural manner of death. With a few exceptions, these cases usually occurred without significant public awareness. Detailed investigation and adequate prevention of custody deaths are of public interest.

Custody deaths are of significant social interest. By the current State Medical Examiner's Regulation in New Jersey, all custody deaths (involving either law enforcement agency or other institutional facility) are investigated by local medical examiners. The study discussed the common cause and manner of death for all custody deaths in northern New Jersey during the last 5 years.

A retrospective record review was conducted at the Regional Medical Examiner's Office in Newark, New Jersey to identify all reported custody deaths from January 2001 to December 2005. The Newark Regional Medical Examiner's Office covers four counties in northern New Jersey, with a population of 2.2 million. Protocol for custody deaths requires an on-call medical examiner and an in-house medico-legal investigator to attend scenes together. All custody deaths are mandated to be autopsied, except for those occurring after a prolonged hospitalization for well-established natural diseases. In this study, available reports from autopsy, scene investigation, toxicology, hospital medical records, and law enforcement agency were reviewed. Both the cause and manner of death were reviewed, with special attention to non-natural manners of death, including suicide, accident and homicide.

During the years of 2001 to 2005, there were a total of 177 custody deaths, with 141 deaths under the custody of law enforcement personnel and 36 deaths under the custody of institutional facility personnel. All cases were reported to and investigated by the Regional Medical Examiner's Office, with approximately 64% (113 deaths) of those individuals autopsied and the remaining 36% (64 deaths) with external examination plus toxicology analysis. Of those 177 deaths, 70% were under the age of 50, 81% were male and 28% were Caucasian. About 128 deaths (73%) were due to natural diseases. The most common causes of natural deaths were cardiovascular disease (45 cases), end-stage acquired immunodeficiency syndrome (26 cases), non-AIDS related pneumonia / sepsis (18 cases), and end-stage malignancy (14 cases).

A total of 49 custody deaths (28%) were determined to be due to non-natural manner of death, including accident (21 cases), suicide (18 cases), homicide (8 cases), and undetermined (2 cases). Acute substance abuse (predominantly cocaine and opiates) accounted for most of the accidental deaths (19 out of 21 cases). Hanging accounted for most of the suicidal deaths (17 out of 18 cases). The eight cases of homicidal deaths included five with "blunt injuries," two with "gunshot wounds," and one with "mechanical asphyxia complicating physical restraint." The two cases of "undetermined" manner of death included one with "pulmonary thromboembolism secondary to deep vein thrombosis of legs" and the other with "blunt force trauma of torso."

Two high-profile police custody deaths involved drug intoxication, "excited delirium" and violent restraint. The presenters attributed the cause of death as "sudden death due to acute intoxication with violent behavior requiring physical restraint" and "cardiac arrest following restraint for drug induced delirium." The determination of manner of death (i.e., accident vs. homicide) for police custody deaths requires careful scene investigation and interviewing of all relevant witnesses.

Custody Deaths, Cause of Death, Manner of Death

E20 Attending Court Summons By Doctors — A Burden or Necessity

T.D. Dogra, MD, and Sanjeev Lalwani, MD, AIIMS, Forensic Medicine, AIIMS New Delhi, FTA-201 AV Nagar, New Delhi, Delhi, Delhi 110016, INDIA*

After attending this presentation, attendees will learn about the Indian system of court summons in medicolegal cases.

This presentation will impact the forensic community and/or humanity by demonstrating how Indian system of Court summons to expert witnesses compares with that of other developed countries in an effort to improve the system in India.

Subpoena or summons is a writ compelling the attendance of a witness in a court of law, at a specified place and time and for a specified purpose under penalty. In subpoena *duces tecum*, the witness is summoned only to submit a document. Under Criminal Procedure Code, 1973 of India, the witness can be called in the court of law by prosecution, defense and by the court itself. Section 45 of Indian Evidence Act (1872) defines expert witness as “a person who has been trained or is skilled in technical or scientific subject and capable of drawing opinions and conclusions from the facts observed by himself or noticed by others.”

Medical evidence is in two forms, documentary and oral. Documentary evidence includes all documents produced for the inspection of the court (Indian Evidence Act 1872) such as *medical certificates* (illness, insanity and death), *medico legal reports* (assault, poisoning, accidents, rape and examination of exhibits), *postmortem reports* in cases of unnatural death and *dying declaration*.

Under section 293 CrPC the ballistic expert, fingerprint expert and handwriting experts are exempted to be summoned by the court of law, as their report is admissible as such; however, they can be summoned on the request of defense counsel. The opinion sent by the doctor in writing cannot prove itself. It is essential that the medical expert should step into witness box for oral evidence; otherwise opinion expressed by him in a communication to one of the parties could not be treated as evidence under the Indian Evidence Act. Therefore, summonses are issued by the court of law and served to doctors for expert evidence. This results in receipt of large number of court summonses to the doctors dealing with medico-legal work.

Offenses having punishment up to seven years are dealt in Magistrate's Court and offenses having punishment more than seven years, life imprisonment and capital punishment are dealt in Session's court. High court deals with appeal cases.

The department receives about 1624 summonses per year from various criminal and civil courts, motor accident tribunals pertaining to offenses against body, road traffic accidents, sexual offenses, attempt to murder, culpable homicide, and juvenile justice board. In addition summonses are received from army courts (Court-Martial), vigilance inquiries, departmental inquiry, and inquiry commissions set by the government.

In 384 (23.64%) of cases summonses were received after the gap of 7-9 years of preparation of documents. On average 3-4 hours are spent to attend the court within the city and deposing the evidence while in case of out station court, it shall depend upon the distance and manner of transport available. In many cases doctor has to appear repeatedly on demand of defense counsel for cross-examination. The maximum summonses (842, 51.85%) are received from the magistrate's court followed by session court (722, 44.46%) and juvenile justice board (60 (3.69%). 910(56.03%) summonses were related to clinical cases and 714(43.97%) to postmortem reports.

Many of the doctors take these summonses as a burden as they causes loss of time and unwelcome cross examination by the defense counsel, which may last , in some cases, for hours to days. In the author's opinion this system is beneficial, as the medical evidence is

thoroughly examined by the prosecution and cross-examined by the defense counsel eliminating the chances of error. Further, due to apprehension of appearance in a court of law, the doctors prepare medico-legal reports carefully and the records are kept properly.

Summon, Medicolegal, Expert Witness

E21 Accreditation vs. Total Quality Management: Do We Need Either? Do We Need Both?

John R. Nixon, BEng, MBA, Athena Research & Consulting, PO Box 66, Bippus, IN 46713*

After attending this presentation, attendees will learn what accreditation and Total Quality Management (TQM) are, and how they may be implemented in laboratory environments. Additionally, attendees will be presented with an overview of the pros and cons of using each system in a laboratory / legal environment, and the possible benefits and pitfalls of implementing an organizational strategy that combines both techniques.

This presentation will impact the forensic community and/or humanity by demonstrating how there is increasing concern among criminal justice professionals, and society at large, that laboratory accreditation leaves much to be desired. This paper reviews the pros and cons of accreditation, and presents alternative solutions.

Hypothesis & Proposition: Is it true that accreditation improves the quality and reliability of the laboratory end product? Would a total quality management approach be an improvement over accreditation or, in an ideal world, should the two be combined?

Synopsis: In their quest to improve customer service, and the scientific product, some laboratories have embraced ISO 9000 accreditation and many crime laboratories have opted for the American Society of Crime Laboratory Directors (ASCLD) accreditation scheme. However, the majority of successful organizations in the general business world operate a total quality management (TQM) strategy. Should TQM be applied to the laboratory, or should a hybrid approach be used?

This paper identifies the key attributes of each approach, and explores how the formulation and implementation of such managerial initiatives can influence the degree of success achieved. The study poses key questions such as: are these two systems mutually exclusive, or could they be combined? Finally, the possible benefits and pitfalls of combining the two approaches are discussed, and human and financial issues are considered.

It has been difficult to overlook the significant media coverage regarding crime laboratory scientific output, staff competence, staff integrity, and wrongful convictions. The Fort Worth Laboratory scandal is fresh in many minds, as is the multi-day crime laboratory deficiency expose⁷ published by the Chicago Tribune in October 2004. Even the once untouchable FBI Laboratory HQ in Quantico, VA has not escaped scandal and criticism in recent years. When Illinois Governor George Ryan commuted the sentences of numerous prisoners from death to life, one of the concerns he cited was his lack of confidence in crime laboratory work.

The true victims of these deficiencies are the US justice system - the backbone of a civilized society - and those individuals who have lost their life and/or liberty due to scientific and/or managerial deficiencies.

Many in the legal profession, and elsewhere, have been appalled by the media revelations. Society is now asking if the number of wrongful convictions can be reduced by improving the accuracy and reliability of crime laboratory output, and if so, how are these improvements achieved?

The laboratories themselves have not ignored these issues, and have made efforts to improve the situation. These efforts have primarily

consisted of accreditation schemes such as ISO 9000, or that run by the American Society of Crime Laboratory Directors (ASCLD). However, whilst these initiatives may well have improved laboratory standards to some extent, they do have their shortcomings and their detractors. The continuing adverse media coverage is indicative that yet more needs to be done. Many people have criticized accreditation as an exercise in credibility, rather than quality.

This paper explores the fundamental principals behind accreditation, and highlights its potential benefits and pitfalls, particularly in the context of its application in an environment populated by highly qualified scientists. Accreditation is considered in terms of system design, planning, implementation and, most importantly, its 'fit' to the crime laboratory working environment and the scientists employed therein.

The concept of accreditation is compared to the widely used, and highly successful, organizational strategy of Total Quality Management (TQM). The core concepts behind TQM, its organizational and industry 'fit', and its successful implementation are discussed. The potential benefits and pitfalls of adopting TQM in a laboratory setting are considered, with particular emphasis on the human factor.

The concept of a hybrid strategy for the science laboratory is considered in an effort to combine the strengths of each approach, whilst minimizing the drawbacks.

In addition to the potential benefits and drawbacks to the scientific bottom line, the impact of these systems and strategies on organizational culture, staff morale, plus recruitment and retention are discussed. Given that the majority of crime laboratories are publicly funded, financial issues are also considered.

In the final analysis, it is evident that the current system of laboratory accreditation has not secured the trust of society at large, and in particular, not the trust of those professionals who work within the criminal justice system on a daily basis. There is no easy fix, and improvement is going to require time, effort, funding, and most of all, motivation from key stakeholders within the criminal justice system.

Laboratory, Accreditation, Management

E22 Ensuring the Continued Role of Science in the Forensic Examination of Trace Evidence

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The goal of this presentation is to give the audience an understanding of the extent to which a thoughtful and creative scientific approach to the examination of forensic evidence can provide information beyond a standardized, protocol-based examination. Furthermore, the participant will be provided with successful case-based examples of circumstances when such investigations are applicable and why protocol-based approaches can be inherently limiting in the most demanding investigations.

This presentation will impact the forensic community and/or humanity by demonstrating the critical importance for retaining an outlet for a purely scientific-based approach to the examination of forensic evidence that is not subject to protocols and accreditations that are becoming increasingly common amidst the growing legislative pressure for certification and accreditation among forensic scientists and laboratories.

The goal of this talk is to discuss the roles of science, scientists and technicians in forensic laboratories in light of the increasing influence of protocol-based examinations and the growing number of accredited laboratories. It should be noted that purpose of this talk is not an attempt to deconstruct the inevitable growth of protocol-based examinations, but

rather to point out the real and necessary need for the presence of non-accredited laboratories that specialize in analyzing non-routine samples within the forensic science framework.

When speaking and writing about forensic science policy, too often the terms science, scientist, and technician are muddled. Simply put, science represents the application of logic to the solution of problems. A scientist is one who applies a scientific approach. A technician follows directions without necessarily understanding the basis for an analysis or its interpretation. In regards to protocol-based examinations, protocols typically are designed by scientists, individuals that understand the science behind a particular type of analysis well enough to standardize a given procedure for the purpose of making a certain subset of analyses routine. In these cases, the standard procedure can be considered scientifically valid when applied to the proper types of samples. However, the person that applies these procedures is *not* a scientist, but a technician. The result of such an analysis *may* be scientifically justified. In drug and DNA analysis, technicians play a necessary and important role in the forensic system and their results are generally adequate. It should be noted that a) when a fixed protocol is applied to any sample, some finite amount of ancillary information will always be lost and b) there is always a finite percentage of cases that do not conform to the protocol.

In categories of evidence that are subject to greater variability (*i.e.*, trace evidence), attempts to confine analyses to standard procedures and protocols have a larger potential for overlooking relevant analytical data or applying the wrong analytical tools, both of which can very easily lead to incorrect interpretations of evidence. In many of the most advanced (*i.e.*, difficult) trace evidence cases, the most significant evidentiary information can only be extracted through analyses custom-tailored to the particular evidence of the case. This can require instrumentation, techniques and expertise not considered in a typical protocol. While these cases may be small in number, the evidence can be certainly no less important than that examined in more routine types of analysis. Arguably, trace evidence may be more important in such cases, because it may be the only remaining avenue of inquiry.

Unfortunately, with the growing prevalence of laboratories that operate on standard and often inflexible protocols, the need for customized analyses of forensic evidence is often overlooked when legislation is considered. As a result, states are beginning to require accreditation for specific types of analyses, or in certain instances, accreditation for all forensic analyses. This leads to a number of problems and contradictions. For example, it is a common practice for accredited laboratories to bring in experts in a particular field from a non-accredited laboratory for advanced training. However, though recognized as an expert by the crime laboratory, such an instructor is not permitted to testify in that state's court system. As another example, a non-accredited laboratory may be used to identify investigative leads from available evidence; however, should these leads come to trial, such an expert would not be permitted to testify. These points will be further illustrated through case-examples.

In conclusion, protocol-based analysis is a necessary reality of forensic science; however, by design, protocol-based analyses encourage a technician mentality. While this may be considered acceptable when processing large numbers of relatively similar samples, deficiencies in protocol-based approaches become more significant when attempting to constrain more variable types of evidence to this approach. Therefore, even after protocols have been developed for all types of evidence, there will always be a need (even if not recognized by legislative bodies) for scientific analyses free of protocol-based constraints to be able to extract the most information from possible from a sample. Finally, it should be noted that only by continually applying new (non-standard) techniques that forensic science will continue to develop.

Trace Evidence, Accreditation, Protocol

E23 Examining Bloodstain Patterns to Facilitate DNA Testing

Thomas L. Martin, Crime Scene Forensics, LLC, PO Box 515, Red Hook, NY 12571*

After attending this presentation, attendees will be able to identify specific types of bloodstain patterns at a crime scene, or on bloodstained evidence submitted to a crime lab. This will help narrow the scope of bloodstain evidence to be tested by the forensic laboratory.

This presentation will impact the forensic community and/or humanity by setting guidelines for testing bloodstains, and ensuring that the most probative evidence is given priority. This presentation will assist attendees in recognizing bloodstain patterns with the most probative value.

At any given crime scene involving significant bloodshed, it's not unusual for the crime scene investigator to collect hundreds of bloodstain samples. Crime scene investigators are trained to collect as much evidence as possible before the crime scene is released. This is a good practice as there are no second chances to collect additional evidence at a later time. Most forensic crime laboratories operate within personnel and budgetary constraints. As a result, cases are often prioritized, and in cases where hundreds of items of evidence are collected, it is neither possible nor practical for the lab to test all items collected. This can create a disparity between the objective of the crime scene investigator, who is trained to collect "everything" and the laboratory analyst, who must prioritize evidence for testing.

Once the evidence has been collected, and is being prepared for DNA testing, a review should be conducted by the crime scene investigators, case investigators, attorneys, laboratory personnel, etc., to determine which evidence has the most probative value. This evidence would be most pertinent to the case, and should be given priority by the laboratory. The proper identification and evaluation of bloodstain evidence can facilitate this procedure. This presentation will assist attendees in recognizing bloodstain patterns with the most probative value.

Bloodstain, Evidence, DNA Testing

E24 Frequency of Occurrence and Magnitude of Plus Four (n+4) Stutter in Forensic DNA Profiles

Carolyn D. Rowland, MS, FBS, 2850 Presidential Drive, Suite 150, Fairborn, OH 45324; and Dan E. Krane, PhD, Wright State University, 3640 Colonel Glenn Highway, Biology, Dayton, OH 45435*

After attending this presentation, attendees will understand the frequency of occurrence and magnitude of plus-four (n+4) stutter in forensic DNA profiles.

This presentation will impact the forensic community by demonstrating empirical data to support the occurrence of plus-four stutter in forensic DNA samples.

Stutter is a common technical artifact of the PCR amplification processes used by forensic DNA profiling laboratories. Crime laboratories routinely use filters to recognize and discount signals associated with n-4 stutter but usually do not take into consideration the possibility of different but related stutter artifacts such as n+4 stutter. An examination of 220 single source reference samples suggests that recognizable n+4 stutter occurs frequently during the course of routine casework: 36 instances of n+4 stutter were observed in a total of 28 reference samples that had been genotyped during the course of routine casework by 15 different laboratories across the United States. Peaks

were considered to be n+4 stutter if they met six criteria: 1) they were in an n+4 stutter position; 2) they were greater than or equal to 50 but less than 4,000 RFUs in height; 3) they could not be explained as being due to n-4 stutter; 4) the primary peak before the target peak was between 900 and 4,000 RFUs; 5) peak height imbalance suggested it did not correspond to a true allele; and 6) its peak-height-to-peak-area ratio made it inconsistent with both spikes and blobs. The magnitude of n+4 stutter peaks relative to the primary peaks that they are associated with is considered, and a conservative filter (5.9%) for the identification of stutter artifacts in the n+4 stutter position is proposed.

N+4 Stutter, Electropherograms, Forensic DNA

E25 Resolution of Forensic DNA Mixtures

Dan E. Krane, PhD, Wright State University, 3640 Colonel Glenn Highway, Biology, Dayton, OH 45435*

The goal of this presentation is to present an objective means of resolving individualities between the DNA profiles of distinct contributors to two-person mixed DNA profiles.

This presentation will impact the forensic community by demonstrating that the statistical weight of a single source sample is far greater than that of a mixed DNA sample. The approach described here will allow analysts to resolve various types of mixtures into pairs of single source samples.

Samples containing DNA from two or more individuals can be difficult to interpret. The striking difference in the weight of the DNA evidence associated with single source and mixed evidentiary samples has motivated the development of approaches that attempt to elucidate the genotypes of the individual contributors from mixed evidentiary samples. The reality of mixed STR DNA profiles is that some loci cannot be resolved into two single genotypes because the observed electropherogram data provides equivalent or very similar support for two or more of the competing alternative hypotheses of genotype combinations that could account for all the detected alleles.

This study describes and tests a novel methodology that provably determines which alternative hypotheses of genotype combinations are mathematically feasible (in light of peak height balance and additivity expectations) and which should be eliminated from consideration due to its failure to satisfy one or more objective rules. The approach rests primarily on the same two principal assumptions of existing resolution methods: (1) that the number of contributors is known (or explicitly hypothesized) and (2) that alleles from the same individual will be present at approximately the same intensity ("in balance" within a specified margin of error). Each locus is considered separately. When only a single combination of genotypes is supported by the underlying data, random match probability calculations can be used to describe the rarity of those individual genotypes. In instances where some but not all alternative hypotheses of contributor genotypes can be eliminated from consideration, a combined-probability-of-inclusion-with-constrained-hypotheses value for a mixed DNA profile can be calculated.

This approach is demonstrably objective as only information from the evidentiary sample is required for resolution. Eight two-person nine-locus mixture ratios ranging from 5:1 to 1:28 were examined to validate this approach. Every mixture had at least six loci that were either fully or partially resolved. The approach is robust enough to demonstrably handle situations of allelic dropout. Failures observed in the method were due to low DNA concentrations with the presence of technical artifacts. The method is also amenable to both computer automation and can be customized with constraints that have been validated by a given testing laboratory.

DNA, Mixture, Random Match Probability



F1 RFID Tag in Dentures as a Tool for Identification

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After attending this presentation, attendees will learn the potential use of a radio frequency identification (RFID) tag implanted in an upper complete denture for identification process.

This presentation will impact the forensic community and/or humanity by demonstrating how the use of a microchip transponder in dentures can open a new prospective to the storing of dental patient clinical history, information regarding dental materials used and ultimately, personal medical data used for potential identification.

Forensic odontological identification is based on the comparison of antemortem and postmortem dental records. The insertion of a radio frequency identification (RFID) tag in dentures could be used as an aid to identify decomposed bodies by storing personal identification data in a small transponder that can transmit to a reader connected to a computer. The RFID technology was introduced for the first time in 1940, but only in 1997 did its use in this field become a possibility thanks to the production of low cost tags. These are a branch of technology called "automatic identification and data capture" and are used to identify, locate and track people, animals and assets. A possible new use of this technology is forensic, namely as an aid in identification.

In pursuit of this development, an Italian RFID manufacturer was asked to provide specimen tags. With the assistance of a dental technician's laboratory a small RFID tag was incorporated into the final manufacturing of a sample complete upper denture and tested for transmission. For this preliminary work the authors will present the technical manufacture of dental prosthetics with the incorporation of the microchip transponder. Twenty ready made upper dentures were geometrically evaluated in order to deduce the best sight for implantation of the tag and obtain a wearable denture. Finally, the RFID implanted in the denture was tested to verify its efficacy and distance of effective data transmission. The authors will give a general overview of the different RFID's available in the market, their technical descriptions and their working principles. In this study a passive, 10 mm length, read-only tag with a low frequency operative frequency was chosen. This choice will be explained with special emphasis as to the frequency as RFID's are categorized by their radio frequency. In fact, only low frequency, 125 - 134 kHz, are employed for veterinary use and are regarded acceptable for human use.

The main object of this presentation is to demonstrate the feasibility in the manufacturing of a dental prosthetic and the technical protocols for its implantation in the denture resin and its working principle.

The information from this study should be considered a preliminary test for RFID-tags for forensic deployment, and to give some indication and suggestions for the design, selection and implantation of the ideal tag in a complete upper denture.

Further research and tests are needed in order to verify human compatibility and technical performance of the tagged denture under static and dynamic conditions, as it would be in an ordinary use during mastication and under conditions in which a forensic identification is necessary as is the case after major accidents or mass disasters.

Radiofrequency Identification Tag, Denture, Forensic Odontology

F2 When Right Is Wrong: Methods for Resolving Cold Identity Cases

Dana Austin, PhD, Tarrant County Medical Examiner's Office, 200 Feliks Gwozdz Place, Fort Worth, TX 76104-4919; Kathleen A. Kasper, DDS, 1514 East Beltline Road, Suite 100, Carrollton, TX 75006; and Roger D. Metcalf, DDS, Tarrant County Medical Examiner's Office, 200 Feliks Gwozdz Place, Fort Worth, TX 76104-4919*

After attending this presentation, attendees will understand the resources available to medical examiners/coroners, law enforcement and families to aid in resolution of long term unidentified remains and missing persons cases.

This presentation will impact the forensic community and/or humanity by encouraging the forensic community to continue working older unresolved identity cases. The current available resources that should be utilized in such cases are presented. By highlighting an error that occurred in this case study the forensic community will be made aware of pitfalls to avoid.

This poster documents the path to identification of female skeletal remains discovered in Johnson County, Texas in 1993. A mistake in dental information entry into NCIC eliminated the decedent from further consideration until a cold hit in the National Missing Persons DNA Database alerted investigators to the true identity of the remains. Attendees will learn the resources available to them in cases of long-standing unresolved identity cases.

In August 1982 Donna Williamson disappeared from North Richland Hills, TX. Her vehicle was found abandoned and she was never heard from again. In May 1993, skeletal remains were recovered in Johnson County Texas. The local medical examiner evaluated the partially recovered remains and entered the biological profile into the National Crime Information Center (NCIC). In June 2003, the case was revived by the Johnson County Sheriff's Office. At that time, bone was submitted to the Texas Missing Person's DNA database and the rest of the evidence was submitted to the Tarrant County Medical Examiner Anthropology laboratory. An anthropology exam and facial reconstruction were requested.

In July 2003, the NCIC entry was modified on the unidentified remains including charting of the maxillary teeth. The mandible was not recovered. The anthropology examination determined that it was necessary to lower the age interval and expand the postmortem interval. Multiple stab wounds were detected thus changing the cause of death from undetermined to homicide. The new biological profile indicated a white female, aged 16 to 23 years, with a postmortem interval of 5 years minimum. The probable year of birth was estimated to be 1952 to 1972 and the probable date missing was estimated to be 1975 to 1988. The NCIC entry was modified with the assistance of Patricia Blake at the Texas Department of Public Safety Missing Persons Clearinghouse (TxMPCH). Over one hundred potential matches were generated. Donna Williamson was one of the potential names, however she was eliminated along with many others, when the dental information available through NCIC did not match. The postmortem dental profile for the unidentified maxilla did not match the antemortem NCIC dental entry for Donna Williamson because the unknown tooth #14 had a one surface amalgam restoration and Donna Williamson's record showed this tooth with a three surface amalgam restoration. This does not follow a natural progression of treatment and is physically impossible. A dental restoration can get larger over an individual's life span but not smaller.

In August 2003, Detective Rica Garcia, North Richland Hills P.D, reviewed the missing person file of Donna Williamson. Detective Garcia

determined that Donna was still missing and she sought assistance from the TxMPCH to locate Donna's biological relatives and obtain a DNA reference sample. The sample was located and submitted to the Texas Missing Person's DNA Database, housed at the University of North Texas Health Sciences Center in Fort Worth, TX. The Texas Legislature funded the DNA database in 2001 and extractions began in March 2003.

In June 2004, the skeletal remains were identified as Donna Williamson with a probability of maternity equal to 95.21%. This case was the first cold hit for the Texas Missing Person's DNA Database.

The question remained of why the dental profile as entered in NCIC did not match between the unidentified cranium and Donna Williamson. A review of the original dental records showed that the antemortem dental radiographs were originally mounted with the raised embossed dot facing away from the examiner ("dot-down" orientation). Apparently, however, the person reviewing the antemortem dental radiographs made a written dental chart for NCIC data entry assuming "dot-up" orientation. This resulted in a flip-flop of right and left sides. When the raised embossed dot is oriented facing the examiner ("dot-up"), the conditions of teeth 3 and 14 clearly agree between antemortem and postmortem charts. Compounding the confusion was the fact that Williamson's restorations were fairly "symmetrical," i.e., contralateral teeth had very similar restorations, and thus a "right-to-left flip-flop" might not readily be noticeable. This explainable inconsistency did not contradict the strong DNA evidence and Donna Williamson was positively identified.

This case study highlights the need for a trained forensic odontologist to review any dental records before a dental profile is entered into NCIC.

NCIC, Dental Radiographs, Human Identification

F3 Odontometrical Method Useful in Determining Gender in a Sample of Subadult Subjects Using Deciduous Teeth

Francesco Introna, MD, PhD, Valeria Santoro, DDS, Evelina Ciccarelli, DDS, and Antonio De Donno, MD, Section of Legal Medicine, University of Bari, P.ZZA Giulio Cesare N.11, Bari, 70124, Italy; and Gaetano Marrone, DSc, Section of Statistical and Economics Science, University of Pavia, Strada Nuova N.65, Pavia, 27100, Italy*

After attending this presentation, attendees will learn about determination of sexual dimorphism of the deciduous teeth in subadult subjects.

This presentation will impact the forensic community and/or humanity by demonstrating a new method in gender determination using odontometrical techniques.

Introduction: In adult subjects the diagnosis of the sex on skeletal remains is carried out by means of a simple morphological or morphometric analysis looking at the individualization of signs of sexual dimorphism present in the various anatomic regions of which the most significant are the skull and the pelvis.

In sub-adult subjects, however, these anatomic regions can't be used with the same success for the identification of the sex, because they haven't fully expressed their sexual characteristics.

The main objective of this study, therefore, is to assess the dimorphic means of odontometric parameters of deciduous dentition with the aim to reach the diagnosis of sex in sub adults.

Materials and Methods: Eighty subjects from Apulia (South of Italy) were analyzed; the sample included subjects between 6 to 10 years old (43 males and 37 females). For each subject, males and females, measurements of dental diameters and palate diameters were carried out by a digital calliper; palatine diameters were analyzed in previous studies in adult subjects.

Measurements concerned the mesio-distal (MD) and bucco-lingual (BL) diameters, except for the incisal group, where only the MD diameter was analyzed. The MD diameter is the greatest distance between the

approximal surfaces of the crown measured by the calliper held parallel to the occlusal and vestibular surfaces of the crown. The BL diameter is the greatest distance between the buccal surface and lingual surfaces of the crown measured by the calliper held at right angles to the mesio-distal crown diameter of the tooth.

Also measured was the intercanine-maxillary and intercanine-mandibular distance and the intermolar distance in the upper jaw; the first distance was measured from the cusp of the right canine and the one on the left; the second distance was valued positioning the points of the calliper in the central furrow of the second deciduous molars on the right and the left.

Even though all of the dental elements were considered, the statistical analysis was conducted only on those represented in the majority; or rather canines and first deciduous molars, that from previous studies carried out on the topic were found to be more dimorphic.

The measurements performed by digital calliper for each subject were examined statistically calculating the average, the standard deviation and the interval of confidence at 95%.

Results: The results obtained, in accordance with other studies made on topic on different ethnic populations, confirm that: 1) the mesio-distal diameter of deciduous teeth results, in males, were larger compared with the same tooth elements in females, 2) the mesio-distal diameters of the dental elements from primary dentition are more indicative of a sexual dimorphism compared with bucco-lingual diameters, 3) the transverse dimensions of the palate, expressed by the intercanine and intermolar diameters, are markedly larger in the male than in the female examples.

The results obtained, therefore, allow researchers to confirm that dimensions of deciduous teeth in their diameter MD and BL and the wideness of the palate, are very useful in forensic medicine investigations on skeleton remains, isolated skulls, and isolated lower jaws of sub-adults, enabling the presenters to determine a reliable discrimination of the sex with objective criteria.

This study has also confirmed the advantages of the use of a digital calliper compared with a traditional conventional one, whether it be for its speed and simplicity or whether it be for its accuracy in considering the fraction of a millimeter.

Sexual Dimorphism, Deciduous Teeth, Forensic Odontology

F4 Age Estimation of a Sample of 12-15-Year-Old Subjects by a Morphometric Analysis of the Development of the Second Mandibular Molar

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The goal of this presentation is to demonstrate a contribution of age determination through the observation of digital orthopantomographs (OPT).

This presentation will impact the forensic community and/or humanity by demonstrating a useful instrument for the determination of the age of the crime perpetrator without a valid identification document.

The verification of age requested by the Law Authorities represent a useful instrument for the determination of liability of the crime perpetrator without valid identification document.

According to the Italian law, until the age of 14 a minor cannot be charged; while between 14 and 18 years of age the charges are examined in the capacity of the intention and will of the subject in the moment that he or she has committed the crime.

The objective of this research has been to demonstrate a contribution to age determination through the observation of digital orthopantomographs (OPT).

Only the second mandibular molars were considered as study objects (which complete their development around 15-16 years).

The choice of digital technology results from several considerations:

- 1:1 ratio between object and radiographic image
- processing and enlargement of details
- images clearer than the classic technique (especially anterior teeth and apicies)
- false images reduction
- lower exposition time

The research on the OPT was based on a morphometric criterion, which consist in the description, in terms of quantity, of the object's form, expressing mathematical equivalents (numbers) that result from the observation of the object considered.

This method avoids the risks of the morphological technique (traditional) that is subjective and can produce very different results because of the variety of the techniques adopted by the examiners.

The morphological analysis expresses dimensions of the crown and the root as fractions of a final unpredictable size; by morphometric analysis, it is possible to recognize an average dimensional crown-root ratio (with a standard deviation) that could guarantee objectivity to the study.

Only second mandibular molars were considered which allow better radiographic definition without clinical defects of development.

A specific dental software was used for image acquisition, processing and measurement.

This study's method comes from Holtta and Jepsen's previous studies; they both consider the cementum-enamel junctions as landmarks. The observers found the two junctions and with a straight line created two other parallel straight lines; the first one tangent to the highest cusp, the second one tangent to the apex of longest root (or the most apical part of the calcified root in the development phases). To these three lines a perpendicular was added on which the measurements were effected.

In the first phase, this technique was applied to 104 molars with completely developed roots, measuring the crowns and the roots and obtaining a ratio C/R. The average of these 104 ratios was 0.432 ± 0.048 (Standard Deviation).

This average has been used, in the second phase, to predict the value of the total root expected, after measuring the crown and the root in teeth not yet completely in 104 OPT (51 males – 53 females) all between 12 and 15 year-old subjects.

Then the ratio between the partial root and the expected one was determined with a standard deviation and a confidence interval (95%) for both sexes and all ages (12-15).

Concluding, a ratio between C/R of second completely developed mandibular molars was determined from which an estimated reference value (\pm S.D. and Conf.Int.) for every age and sex was created.

In this sample it was found that males of 12 and 13 years have the same average with a confidence interval very similar; the same for females of 13 and 14 years. These facts show a slowing down of the development; so it must be considered that increasing the sample, standard deviation was obtained and a confidence interval reduction with more precise results.

This method allows the assignment of a number to any class of age that comes from a statistical investigation based on objective criteria.

Age Identification, Second Molar, Forensic Odontology

F5 Fluorescence and Structural Degradation in Composite Resins as a Function of Temperature: A Comprehensive Study

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The goal of this presentation is to provide an understanding of the changes in properties of dental composite resins as a function of temperature. Comprehensive analysis was performed including measurement of fluorescence, radiopacity, chemical compositions, and microstructure. The analysis methods used were unequivocal in terms of the conclusion to be made from the data. In particular, fluorescence of composite resins can be used as an aid in location of resins in the human dentition during autopsies. Attendees will understand the temperature range at which these properties are lost and the resulting differences in contrast between tooth structure and restorative material.

This presentation will impact the forensic community and/or humanity in the determination of the conditions under which the chemical and physical properties of dental composite resins are present or disappear. This information could potentially be used to estimate incineration temperatures and conditions endured by burn victims.

The restorative dental work a person receives provides unique individual characteristics, as the likelihood of two dentitions being the same is very low. Therefore, it is important to be able to identify these restorations and also be able to analyze them using instrumental techniques. This may help to determine not only the identity of the victim, but the conditions and environment they were exposed to. With an increase in the public demand for esthetic restorations it is important to understand the characteristics of the materials used in modern dentistry. These characteristics can be measured by methods from which indisputable data can be obtained.

Composite resins consist of inorganic filler particles in an organic resin matrix. The organic component typically contains a mixture of methacrylates together with polymerization inhibitors, initiators and organic dyes for coloration. The methacrylates form the bulk of the resin, and the other components are present at low concentrations. The inorganic particles can form 70% or more by weight of the resin mass. Manufacturers for esthetic effect may also add organic fluorophores. The fluorophores are present in low concentration and therefore would be difficult to identify.

When subjected to increasing temperatures, polymers begin the process of pyrolysis. During pyrolysis, bonds in the long chain polymers are broken, leaving free radicals, which combine with oxygen. As the temperature rises, the organic material breaks into successively smaller fragments, leaving the ultimate reaction products CO₂ and H₂O.

As the fluorescing molecules undergo pyrolysis, the fluorescing property is lost. This can be measured by UV-VIS Spectrophotometry. This technique can determine without question whether any fluorescing properties remain. The breakdown of the bond structure can also be characterized by Fourier Transform Infrared Spectroscopy (FTIR).

Pyrolysis of the organic component of the resin does not affect the inorganic filler particles. Since the radiopacity of the resin is determined by the elemental content of the filler, temperature had no effect on the inorganic elements in the filler. This was measured by quantitative radiography.

As the temperature increases, the inorganic material eventually melts and fuses. This effect was examined by Scanning Electron Microscopy (SEM), which showed the microstructural changes. Although the SEM images are necessarily qualitative, they nonetheless indisputably characterize the structure. For each of the properties surveyed, a valid technique was used for analysis.

In this study, three different brands of resin were analyzed. Discs were prepared and exposed to temperatures from room temperature to

900°C in 100-degree increments for 30 minutes. For each condition, UV-VIS spectra, FTIR spectra, radiographs and SEM images were recorded. Images of the resins under UV illumination were also collected. This combination of techniques allowed characterization of the organic and inorganic components, as well as some interesting properties of the resins.

Visible inspection with UV illumination and also of UV-VIS spectra showed that the resins lost their fluorescence above 300°C. FTIR analysis showed that as the resins were exposed to increasing temperatures, bond degradation did occur, with peaks associated with organic bonds between 2800 to 3000 cm⁻¹ diminishing in intensity. At 200°C and 300°C, a significant decrease in the peaks' intensity occurred, and by 400°C the peaks had completely disappeared, indicating that the organic bonds had been compromised due to the exposure to very high temperatures.

Secondary electron images taken by SEM revealed the structural changes that took place in the resins. Above 300°C, the organic matrix disappeared resulting in a friable assembly of filler particles. At 700°C, the particles fused together in a single glassy mass. Above 700°C, porosity developed in this mass, indicating that there was a volatile component in the glass.

Quantitative radiography was performed using aluminum plates to generate a calibration curve. Radiography showed an apparent increase in radiographic density above 300°C, which coincided with the breakdown of the organic matrix.

The loss of fluorescence above 300°C can help to indicate the temperature of victim exposure. Inspection of the dentition using UV light would reveal to the eye whether or not that temperature had been reached. Radiography would also be a useful tool for resin location at any temperature.

As with any forensic evidence, the more tests one can run, the more reliable the conclusions will be. Some analytical techniques can return unequivocal results, producing evidence that cannot be refuted. In this study, four such techniques were used to analyze changes in restorative resin properties.

Composite Resin, Incineration, Fluorescence

F6 Dental Science Assists Criminal Justice

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The goal of this presentation is to inform those attending of the necessity of introducing hard science in bite mark analysis. Otherwise, this valuable resource may no longer be available under the Federal Rules of Evidence.

This presentation will impact the forensic community and/or humanity by discouraging the analysis of indistinct and unremarkable bite marks. It should also encourage further research to elevate the odontologist's opinion to the level of objectivity, by being able to quantify the occurrence of a given tooth pattern in the population.

The *Daubert* decision now gives the court the responsibility for being a gatekeeper. Testimony may be denied unless the Odontologist can scientifically support an opinion of the link between the pattern and a suspect with some degree of objectivity, e.g., based upon a database, the frequency that the dental characteristics observed would be expected to occur in the population. The court is also interested in the error rate among Odontologists. Criticism of bite mark analysis, labeling it as junk science, has come about because of several high profile cases in which the pattern was linked incorrectly to an individual. This sensational journalism barely allowed credit for the many cases that were appropriately accomplished. The problem is not with the comparative science of bite mark analysis, but in the author's opinion with the case selection, the interpretation, and the strength of the testimony given. The present state of knowledge of the frequency distribution of even unusual dental characteristics does not reach the level of individualization. A virtual identification rivaling that of

mtDNA would require many years and the analysis of hundreds of thousands of samples. Although it is commonly assumed that the human dentition is unique, a literature search reveals only limited research attempting to demonstrate this scientifically.

Indistinct and unremarkable patterns have been over-interpreted as to their evidentiary value. Presently the Odontologist lacks the ability to quantify the occurrence of even a highly bizarre dental pattern and an opinion should be limited to an expression of probability. The question which arises is, how probable? At the present level of knowledge of dental characteristics, an opinion of probable has only limited value as evidence in that the analysis did not permit an elimination of the subject. A database on the frequency distribution of dental characteristics is necessary to provide hard science to the expression of probability in linking a bite mark pattern to an individual. The *Daubert* factors have raised the bar for the admissibility of this type of testimony.

Currently, a two year, multidisciplinary pilot study is underway utilizing computer analysis of a random sampling of the imprints of the teeth of 400 male volunteers, ages 18 to 44. This team involves the dental school, the law school, the state crime laboratory and computer science. These samples reflect the ethnic makeup (Asian, Black, Hispanic, Native American, and Caucasian) of the general population in the dental school clinic. The imprints are registered, digitally scanned and computer analyzed, to begin the development of a database on six characteristics of the human dentition. The expected outcome of this pilot study is to demonstrate what has presumed to be so, is fact; that is, no two of the dentitions analyzed were shown to be the same. A second goal of this pilot study is to examine both the inter-operator and intra-operator rate, which is another of the questions that the courts and attorneys have. Since bite mark analysis is not an automated process, is there a significant difference between examiners?

Objective assessment of a distinct and remarkable pattern that can presently only be subjectively evaluated will eventually be able to be expressed with objectivity. With the establishment of a database, bite mark analysis could transition into hard science.

If this pilot project validates its hypothesis, "*Investigate, using six measurements, the pattern of each of four hundred samples and calculating the probability that any two would be judged to be the same*", this research is then seen as expanding into a long term effort, eventually involving thousands of samples and the collaboration of many researchers from other laboratories to expand the database.

Research, Bite Marks, Database

F7 Bite Mark Research – Antemortem and Postmortem Bite Marks – Part 2

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Upon completion of this presentation, participants will be able to assess the timing of bite marks and the effects of different variables and equipment used.

This presentation will impact the forensic community and/or humanity by underlining the use of UV and ALI photography and other variables to the overall picture of bite mark interpretation.

The learning objective of this oral presentation is to understand the interrelationship of some of the complex principles involved in bite mark analysis.

McGill University's Faculty of Dentistry, the Laboratoire de sciences judiciaires et de médecine légale, Ministry of Public Security for the

province of Quebec, and the Quebec Provincial Police's Identity Section (forensic photography) collaborated for a second year on the study of photographic techniques, materials used for impressions and excision of bite marks, external and intrinsic factors as well as cellular changes affecting bite marks.

Human bite marks were inflicted both in vivo and postmortem by means of mounted vitalium dental casts on a Vice-Grip. Part 1 reported on the affects of bite marks inflicted 45 minutes before death to two and a half hours after death on unshaved specimens, while the current paper - Part 2 - reports the effects on shaved specimens with and without clothing from 45 minutes before death to 45 minutes after death.

The project included the use of videography, digitized photography (color, Ultraviolet, and Alternate Light Imaging), impressions of the bite mark, excision techniques employing different materials (Dorion - type 5), transillumination, tissue preservation, and fixation.

Various other factors including those attributed to the perpetrator, the recipient, the recording of the bite mark, extrinsic factors, lividity, and tissue preservation issues are conveyed.

After attending this presentation, attendees will understand the interrelationship between the variables and some of the more complex principles involved in bite mark analysis.

Reference:

¹ Dorion RBJ ed., *Bite mark Evidence*, Marcel Dekker, New York, 2005.

Bite Mark, Bite mark Research, Timing of Bite Marks

F8 Bite Mark Analysis - Part 1 and 2 Results

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Upon completion of this presentation, participants will be able to estimate the timing of bite marks based upon different variables and equipment used.

This presentation will impact the forensic community and/or humanity by underlining the effects of a person's background, training, education, skill, and experience in bite mark interpretation.

Documentation and interpretation of a bite mark is a complex subject raising many issues¹. One problem pertains to the temporal relation of the bite. Bite mark infliction can occur before or after death.

The healing response to injury applies only to living tissue. Conversely, bite mark injury occurring after death cannot produce this response. Many other variables impact the precision of such estimates¹.

One of the purposes of this current study - Part 2 - is to evaluate whether greater precision on the timing of the injury can be estimated by analysis of the different variables involved and the different tools currently available.

Bite marks were inflicted on anesthetized piglets that were eventually euthanized. Mounted human adult dental casts were mounted on a Vice-grip and the bite marks produced at various intervals on shaved and unshaved specimens, in vivo and postmortem, with and without clothing.

The bite marks were analyzed for different factors including: color changes, distortion, indentation of the epidermis, hair, tissue crushing, variables of skin tissue thickness, abrasions, contusions, laceration, positional relationships, gravitational influence (lividity and non-lividity side), intradermal capillary hemorrhages, antemortem and postmortem cellular damage, temporal changes and content.

The bite marks were photographed, bite mark impressions taken, samples excised, transilluminated, fixed, and analyzed for

histopathological changes. The results of the findings are described and discussed.

Each of the participants documented and analyzed different bite marks and were given digitized images of five potential sets of dental casts for comparison. Photoshop was used for the comparison without access to dental casts. The results of the assessment are conferred for both Part 1 and 2 of the study.

After attending this presentation, attendees will appreciate the complexities of bite mark analysis and the potential problems involved with interpretation. Recommendations are made to minimize this dilemma.

References:

¹ Dorion RBJ ed., *Bite mark Evidence*, Marcel Dekker, New York, 2005.

Bite Mark, Bite Mark Research, Bite Mark Comparison

F9 Bite Mark Photography: Seeing Things Differently, Digitally

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After attending this presentation, attendees will learn information on new digital camera equipment, lenses, and forensic light sources for alternate light and infrared techniques of photography.

This presentation will impact the forensic community and/or humanity presenting new information that will directly affect the forensic community regarding certain digital applications and equipment used in advanced forensic photographic applications.

New technology in digital photographic equipment and its applications to forensic investigation are continuously changing the state of the science. Attendees of this presentation will be updated on some of the most current digital cameras, lenses, and lighting options for advanced photographic techniques in bite mark documentation.

The applications of Alternate Light Photography, Infra-Red, and Reflective Ultra-Violet techniques allow the forensic investigator to see details in bite mark and wound patterns, tattoos, questioned documents, and surveillance that would otherwise be unseen with the naked eye or with conventional color or black and white photography. The impact of advanced photographic techniques is especially useful in the field of Injury Pattern Analysis, wherein bite mark investigation falls.

This presentation will describe recent personal photographic research completed with the new UVIR digital production camera from Fujifilm Corporation. Previous digital camera chips (CCD and CMOS) have been designed to filter out and block the UV and Infrared ends of the non-visible spectrum. The author and others participated in the development of Fuji's new digital forensic S3-Pro UVIR camera that was specifically designed for the forensic industry. As more usage in the public and forensic domain becomes prevalent, it is anticipated that more applications for the camera will be discovered, particularly in the area of fine art photography.

Additional topics will include new forensic light sources available for Alternate Light and Infrared photography, quartz lenses, and accessories that help facilitate the forensic photographer accomplish his work. Present casework wherein all the aforementioned equipment has been employed to demonstrate the results of this research will also be discussed.

Bite Mark, Photography, Digital

F10 Once Bitten, Twice Shy: Or the Case of the Colossal Contusion

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The goal of this presentation is to review information that may and may not be learned from a bite mark specifically focusing on what data the indentations can give in relation to the time of death and aging bite marks based on the bruising coloration.

This presentation will impact the forensic community and/or humanity by giving an approximate time when a bite mark has been made in relation to the time of death if there are indented marks remaining in the bite mark. However, one cannot age a bite mark based on its coloration or the changes it undergoes as it heals. Further research into the behavior of human skin after it is bitten is needed. The time required for indentations created by teeth to rebound, swell, bruise, and heal for different persons and varied locations are only part of the information needed for any temporal analysis to meet the requirements of federal and state rules of evidence.

Background Information: Forensic dentists usually think of the bite mark pattern being compared to the models of suspects. However, there is more information that can be gleaned from a bite mark. Equally as important is recognizing that there is some information that cannot be acquired or deduced.

Summary: During a course in forensic odontology, a sample bite was made on a living willing victim using a set of models mounted on a welder's clamp. The model's teeth were made from white Jet acrylic and the gingival and mucosal areas were made from Jet pink acrylic. A one minute and seven second video was taken to visually record the biting process. The video was taken with a Nikon CoolPix S1 5.1 megapixel camera that has the capability to take short video clips. Photographs were then immediately taken with the same camera to document the first tissue changes. The resultant bite mark was monitored to see how long depressions remained in the skin. At 2 minutes and 30 seconds after the bite was made, the depressions were gone, and the bite mark was swollen. The bite mark was then photographed daily, with a Nikon CoolPix 5700 5.0 megapixel camera, until it was no longer visible. Three months after the bite was made, the area was inspected using a UV light source. An Officer/Evidence Technician of the Naperville, Illinois Police department used an Omnichrome Omniprint 1000, as well as a Blak-Ray Longwave Ultraviolet Lamp, Model B-100A using 115 Volts, 60 Hz and 2.5 Amps. A variety of wavelengths were tried from 400 to 530 nanometers. Red, orange, and yellow goggles were utilized to visualize any mark that might be visible, but no demarcation of any kind was seen. A brief review of the literature concerning the aging of contusions or bruises by their color is instructive when applied to bite marks.

Conclusions: A forensic dentist **may** be able to give an approximate time when a bite mark has been made in relation to the time of death **IF** there are indented marks remaining in the bite mark. However, one **cannot** age a bite mark based on its coloration or the changes it undergoes as it heals. Further research into the behavior of human skin after it is bitten is needed. The time required for indentations created by teeth to rebound, swell, bruise, and heal for different persons and varied locations are only part of the information needed for any temporal analysis to meet the requirements of federal and state rules of evidence.

Bite Marks, Forensic Odontology, Contusions

F11 Determination of Bite Force

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The goal of this presentation is to establish a preliminary study and the basis for measuring and quantifying the force exerted by a human bite in the anterior sextant, reflecting those teeth involved in the injury pattern of a bite mark. And, to build/develop a reference table for the range of human bite force and the variables that affect it.

This presentation will impact the forensic community and/or humanity by providing more research to build a database of factors that affect bite force, and record the variables within different population groups. Once known force ranges are established within given populations more studies can be done to link bite force to the injury patterns they create.

The goals of this presentation are twofold. First, to establish a preliminary study and basis for measuring and quantifying the force exerted by a human bite in the anterior sextant, reflecting the teeth involved in the injury pattern of a bite mark. Second, to begin the process of developing a reference table for the range of human bite force and the variables that affect it.

Introduction: Bite mark injuries and the patterns they leave in the skin are the most challenging cases in forensic odontology. With this in mind, the ability to measure the force that is generated by the human dental complex in a bite mark is an important part of understanding of the type of injury it would then produce in the skin. To say a bite was hard enough to leave an injury is not very scientific. Therefore, a primary evaluation of any bite mark injury should take into consideration the amount of force needed to cause tissue damage in the first place.

Materials and Methods: To measure the force exerted by the anterior teeth a device known as a gnathodynamometer was used. For this study specifically, the gnathodynamometer was a modified design, developed by researchers and engineers at Proctor and Gamble. This study required the fabrication of a bite plate. The bite plate was produced for both the upper and lower anterior segments. Additionally, the surface was designed to accommodate the twelve anterior teeth, for the subject(s) to bite against. These removable metal plates were enclosed in a wet piece of animal hide for the subjects to bite into. The force was recorded in pounds per square inch. Each participant was instructed to bite with maximal force onto the hide-covered plates of the transducer. This process was repeated a total of three times for each participant. The highest of the three recorded values were used for statistical analysis. The dental exemplar impressions produced in the hide were maintained with the study with the subject identification number and pressure reading as part of the database.

For this study all subjects were periodontally stable and had a complete or near complete complement of teeth. Additionally, none of the subjects had removable prosthetics of any kind. All of the participants had a class I occlusal relationship. The total number of subjects in this study was 800 individuals. The subjects were subdivided by age, gender, and race. In each group there were no less than 30 participants. Additional data acquired from the study participants included height, weight, TMJ dysfunction, history of dento-facial trauma, and overbite/over jet relationship of the anterior teeth.

Results: The data recorded in this study were statistically analyzed and documented to show the range of bite force in a given population of individuals and the variables that affect it. More research is needed to build a database of force levels and factors that influence bite force. Also needed are studies of biting force among different population groups. Once known force ranges are established with a given population more research can be done to associate bite force to the types and severity of tissue injuries caused by teeth in skin.

Forensic Odontology, Bite Mark, Bite Force

F12 A Comparison of the Quality of Color Produced by Photographic Film and Digital Imaging Exposed Under Ultra-Violet Light and Measured as a Function of Degrees Kelvin

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The forensic odontologist relies on the faithful reproduction of film and/or digital photographs exposed under various light sources for investigative and evidentiary purposes. After attending this presentation, attendees will be briefed on the evaluation of the differences in color reproduction from these two modalities when exposed to ultra-violet light.

This presentation will impact the forensic community and/or humanity by demonstrating how if one should present evidence based on film or digital reproduction, the possibility exists that the defense might posture this as exculpatory evidence due to the inherent differences in color imaging.

The development of digital imaging has empowered the forensic scientist with a multifaceted investigative instrument. Digital imaging offers instantaneous recording of evidentiary material and a wider range of storage and reproduction modalities. The forensic odontologist relies on image recording and reproduction under various light sources to evaluate the evidence obtained on the initial investigation and to document the conclusions achieved from the painstaking processes of bite mark analysis and/or victim identification. It is vital to all investigators that accurate reproducibility of evidence imaging must be unquestionably accurate. While there has been much documentation on the comparison between photographic and digital imaging with respect to resolution vs. graininess, the literature is notably sparse on comparing the ability of the two media to faithfully reproduce evidence quality color documentation. In a previous presentation the Author evaluated some of the preliminary findings from a project designed to measure the temperature in degrees Kelvin of color images produced by the two media after exposure utilizing 4,800° and 3,200° Kelvin light sources while maintaining the inherent variables as constants. This presentation will deal with a comparison of the color differences between the two modalities when exposed to ultraviolet light.

The objects to be imaged consisted of three plastic report binders: a red, a blue, and a green. Because of the inherent ability of certain polymers to fluoresce, all binders were manufactured by the same company and of the same material to ensure consistency thereby removing this variable from the equation. Two cameras from the same manufacturer were used: a Nikon F4 35mm film camera and a Nikon D-100 digital camera. The same lens, a Nikon 35-70mm macro zoom, was used on both cameras. The lens were used in the macro mode with a lens to object length of approximately 40 centimeters and secured in a Quadrapod copy stand and a LabJax was used to aid in focusing the image. Three portable Ultraviolet handheld light sources were affixed to the legs of the Quadrapod and their light beams were centered on the focal plane of the image. Kodak Gold 35mm 200/ISO film was used and the digital camera was set to the same ISO setting. Because the film chosen was balanced for daylight, the digital camera's "white balance" setting was adjusted for "daylight." Setting the resolution of the digital image was not considered a factor in this experiment.

Each object, the red, blue, and green binders, was imaged according to the following protocol: Ultraviolet on film and then ultraviolet on Digital. A total of three exposures for each parameter per binder were made.

The film was developed by a commercial laboratory utilizing a C-41 process with instructions to not make any color corrections to the final 4x6 prints. The negatives of these images were scanned on an Olympus ES-10s 35mm scanner and stored on a CD. The digital images were printed

on 4x6 photographic paper without color correction by direct placement of the compact flash card from the camera into a Hewlett-Packard #7550 printer. These digital images were also stored on a CD.

A Spectra #4143 Color Temperature Meter was used to measure the color temperature of the various images in degrees Kelvin. Measurements were taken of:

1. The 4x6 film & 4x6 digital prints from reflected light.
2. The CD stored film & digital images from an LCD computer monitor projected by Photoshop.

All measurements were taken in a darkroom environment.

An initial analysis of the measurements showed that all of the images taken in triplicate produced the same measurement. Because the measurement for each parameter would have been universally tripled, it was decided to reduce the statistical evaluation to one measurement for every triplicate image analyzed.

A total of four parameters were considered for each color. The resultant measurements were entered into a spreadsheet, average differences were calculated, and graphs were promulgated and analyzed. While empirically one could say there may not have been any visual differences, the measurements clearly illustrates a difference in color temperatures of 500°, 450°, and 600° for red, blue and green respectively. No conclusions should be made on the results of this preliminary report. What the Forensic Odontologist should be aware of is the possibility that any judgment made on the basis of the color film or digital record may be different from the actual color seen with the naked eye. Further investigation is encouraged.

Ultraviolet, Variation, Imaging

F13 Coordinating the DNA and Pattern Analysis Studies in Bite Mark Cases

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After attending this presentation, attendees will be able to consider the applicability of a proposed method for coordinating the DNA study and the pattern analysis study in a bite mark investigation. The goal is to carefully serve the interests of justice, while providing the conscientious odontologist with some shelter from the turmoil that ensues when DNA and bite mark pattern analysis point in different directions. This occurs when, for example, pattern analysis indicates that Mr. A is the biter, but DNA study determines that the saliva recovered from the bite mark is from Mr. B. In such apparent conflicts the DNA studies have been viewed by the justice system as having the greater validity.

This presentation will impact the forensic community and/or humanity by reemphasizing the need for continuing research and careful attention to proper procedures in all areas of forensics, while demonstrating a method that may enable the conscientious odontologist to honestly and ethically decrease the likelihood for unnecessary conflict, damage to reputation, and possibly litigation in cases in which pattern analysis and DNA studies do not agree.

The proposed method treats the pattern analysis and DNA investigation as parts of a unified approach to the bite mark study, rather than as isolated procedures. It will be described in relation to a case.

In an investigation involving the death of a young child, bite mark evidence was a major issue. Two forensic odontologists concluded that the defendant in the case was the only one of the six individuals with reported access to the child whose teeth could have made the bite marks on the child's body. They concluded their first report with the statement that DNA evidence was also being studied, that such evidence is valuable, and that the bite mark investigation could not be considered complete until the DNA report had also been considered. They indicated that the current report should be considered preliminary, and might be further validated or possibly rebutted by the DNA evidence. Months later, the DNA report indicated that the DNA profile from the bite mark was the same as that of

the defendant, occurring only once in approximately 7.4 trillion males.

In this case the DNA evidence helped to validate the pattern analysis. But if there had been a disparity in the findings, the stage had already been set for a collegial and cooperative evaluation of the apparent discrepancy. In the worst case, the pattern analysis might have to yield to the DNA findings on the basis of DNA's well-researched error rates and other data, including population studies of ethnic groups. But here, too, the impact of the disparity would be minimized by the honest and candid discussion "up front" regarding the relative advantages and limitations of pattern analysis. Importantly, the odontologist would not be tempted to defend a questionable position because he had locked himself into it. He/she would be free to move, without embarrassment, wherever the evidence might lead.

Some might feel that the above approach unduly denigrates bite mark evidence. But after the defendant was convicted in this case, the prosecutor went so far as to write a letter to the Chief Medical Examiner lauding the value and importance of the bite mark evidence. And prior to trial she beat back defence's efforts to exclude the bite mark evidence because it would "unduly influence the jury." Also, during trial she declined the defence's repeated offer to stipulate to the odontologist's testimony because the prosecutor wanted the judge (who tried the case) to see the odontologist's exhibits of the pattern analysis. Clearly, the pattern analysis was regarded as powerful evidence by both the prosecution and defence attorneys despite the cautionary words that had been offered in the odontologists' report.

Bite Marks, Pattern Analysis, DNA

F14 The Forensic Pitfalls of Avulsive Bite Injuries: Medical and Dental Features of Importance to Odontologists

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After attending this presentation, attendees will understand a) The broad presentation of bite mark injuries and in particular their severity, b) The medical procedures that are used to treat avulsive bite marks and c) The impact that such treatments have on forensic analysis.

This presentation will impact the forensic community and/or humanity by demonstrating how avulsive bite mark injuries continue to be analyzed by forensic dentists and yet many have undergone medical treatment prior to evidence collection. This presentation will demonstrate that such injuries are often unsuitable for physical comparison.

Introduction: Bite mark injuries continue to represent important physical and biological evidence in some of the most serious of crimes including rape, homicide, physical abuse, and assault. Odontological societies worldwide have developed protocols for the collection of evidence from both the victim and suspect and a range of analysis methods exist; many of which are based upon the physical comparison of the suspect's dentition to the bite mark wound using transparent overlays.

Bite marks can be categorized in a number of different ways; based on their severity, forensic significance or even anatomical location. A recent index has been developed that assess the severity of the injury and relates this to this likelihood of sufficient forensic evidence being available for a physical comparison.

Cases: A recent audit of bite mark cases from the North West of England demonstrated that over 39% of bite marks fall into the 'avulsive' category; i.e., those injuries in which material has been removed. Such injuries are commonly seen on the ear, nose, and occasionally distal aspects of the digits. There have been a number of cases where such injuries have been analyzed and an odontological opinion rendered that an individual suspect could be positively identified.

In all such cases medical treatment had been undertaken prior to the collection of the evidence. Medical treatment of bite injuries will typically involve thorough wound cleansing, debridement, and suturing. Each of these treatments has the possibility to alter the physical dimensions and appearance of the bite injury thus rendering it unsuitable for analysis.

A range of cases will be shown, each demonstrating the inherent difficulties in assessing such injuries and the pitfalls that can occur when it is attempted. Details of the medical procedures involved in treating such injuries is essential knowledge for all forensic dentists and these will be described in full with the implications for physical comparisons clearly explained.

Conclusion: It is the authors' view that avulsive bite mark injuries are unsuitable for analysis after medical treatment and the use of such injuries for physical comparison prior to treatment is problematic. It is proposed that guidelines for bite mark analyses be extended to include a recommendation that certain injury severities; i.e., those at the extremes of the severity scale (minor bruising and avulsion) be deemed inappropriate for bite mark assessment.

Bite Mark, Avulsive, Treatment

F15 Bite Mark Analysis of a Fatal Dog Mauling Case Using Forensic Photo Frames Camera Apparatus

Elizabeth R. Smith, DDS, PO Box 55297, Virginia Beach, VA 23471*

After attending this presentation, attendees will learn of an innovative camera apparatus technique using Forensic Photo Frames in achieving non-distorted patterned injury images for bite mark analysis.

This presentation will impact the forensic community and/or humanity by demonstrating a new technique using Forensic Photo Frames to capture and document non-distorted images in a multiple pattern injury dog mauling case.

The goal of this presentation is to introduce the attendees to an innovative camera apparatus technique using Forensic Photo Frames in achieving non-distorted patterned injury images for bite mark analysis.

On October 04, 2005 in a rural Suffolk city, a two-year-old male toddler awoke from a night of sleeping to find that he was hungry and ready for breakfast. He alone walked downstairs to the kitchen and treated himself to a box of breakfast cereal. In the home were his parents, a male Pit Bull Terrier Mix, and a nursing female Pit Bull Terrier Mix with pups. During the time of his morning meal he was violently assaulted and physically subdued by one and possibly two of the adult dogs. The victim had numerous bite injuries over majority of his body with the most brutal bites to the head and neck region. The child was Life-Flighted to Children's Hospital in Norfolk where he eventually succumbs to his injuries. Both adult dogs and pups were taken to animal control to await the results of the bite mark analysis. Evidence later determined that the child's parents were in an upstairs bedroom using illicit drugs at the time of the mauling. Reports indicate the male dog was a stray and typically stayed outside the home. Given details state the male dog was used to protect the couple's marijuana crop. Neighbors tell a history of the male dog biting and nipping others in the community.

The author of this abstract was contacted by the lead investigator of the Suffolk Police Department and the Office of the Chief Medical Examiners Tidewater District to examine multiple soft tissue pattern injuries sustained by the decedent. The author was asked to present findings and conclusions regarding any or all of the suspects related to the case. Photographs of the victim's patterned injuries were taken using the Forensic Photo Frames apparatus. The adult dogs were examined, photographed also using the Forensic Photo Frames device. Dental impressions were taken on the adult dogs whereby a bite mark analysis was completed. The conclusion was that the male dog was the probable biter and that the female dog could not be ruled out. The parents pleaded

guilty to involuntary manslaughter and child abuse causing a serious injury.

Documentation by photography is a first and important tool in the investigation of a crime scene. Depending on the nature of the incident there may exist one opportunity to correctly retrieve photographic evidence. The purpose of the Forensic Photo Frame device is to provide the responder with the best tools and techniques to capture pristine photographs. The easily attachable apparatus applied to a camera when properly used can reduce or eliminate distortion allowing for a 1:1 ratio of high quality images to be documented. This type of evidence can be an influential benefit in the judicial system.

This presentation will demonstrate a new technique using Forensic Photo Frames to capture and document non-distorted images in a multiple pattern injuries dog mauling case.

Dog Bites, Forensic Photography, Angular Distortion

F16 WinID on the Web

James McGivney, DMD, 11 Ronnies Plaza, St. Louis, MO 63123, USA*

After attending this presentation, attendees will understand the use of computers in mass disaster human identification efforts.

This presentation will impact the forensic community and/or humanity by assisting the forensic community in appreciating the use of computers in human identification.

A beta version of WinID on the Web was released in April 2006. WinID on the Web or WotW will be the successor to WinID3.

WinID3 is a widely distributed computer program that assists in the identification of individuals. WinID3 has helped identify victims of the World Trade Center, Pentagon, and United Airlines Flight 93 terrorist acts of September 11, 2001.

WinID3 can also be used in maintaining missing person/unidentified body data systems for governmental and non-governmental organizations.

WinID3 has been linked to a digital radiographic system to store, manipulate, and display digital images. The most common digital images are dental radiographs, but other images with identifying content have been used successfully. WinID3 was used in a paperless mode at the Carville, LA morgue by DMORT personnel in the aftermath of Hurricane Katrina. The totally digital environment allowed for very rapid processing of the hurricane victims.

The WinID dental coding system has primary, secondary, and text descriptors for describing an individual's dentition. This well known coding system is used in WotW. WinID3 has non-dental fields available to hold other information useful in human identification. The WinID3 data-fields have been expanded in WotW to make a robust human identification database.

WinID3 is written in Microsoft Visual Basic and uses a Microsoft Access database. These development and database programs represent mature technologies. Information systems are migrating to the World Wide Web (WWW) to facilitate the exchange of ideas and data. WinID on the Web makes use of ASP.NET 2.0 with code behind in C#, using a Microsoft SQL 2005 database.

Extensible Markup Language (XML) is a method for organizing and storing data that lends itself to use by computers. In late 2005 an ongoing research study was launched. The purpose of the study was to find and catalog the complete data terminology useful in human identification. The results-to-date of the study have been encoded in XML, and used as data-fields in WotW.

WotW incorporates many of the well-known features of WinID3. The Beta version is available online at <http://www.winid.com/Home.aspx>. WotW allows users anywhere in the world to view images and data, and to access and add to the current human identification database. The user is able to find best matches between antemortem and postmortem records by using automated searches and by sorting and manipulating data.

It is envisioned that WotW will allow internet-connected users in diverse geographical locations to enter antemortem data for suspected victims of mass disasters. Workers at the disaster site will examine recovered human remains and enter postmortem data into WotW. WotW has many comparison and sorting algorithms that facilitate human identification and enable comprehensive report generation.

In a real disaster situation WotW will be available on a website specific to the incident. Access to the website will be limited to authenticated users with appropriate authorization.

Mass Disasters, Computers, Human Identification

F17 WinID Expansion as an Aid to Identification in Multiple Fatality Incidents

Karen M. DePaoli, DDS, 616 Marguerite Avenue, Corona del Mar, CA 92625; Jim McGivney, DMD, 11 Ronnies Plaza, St. Louis, MO 63126; and Paula Brumit, DDS, Bruce A. Schrader, DDS, and David R. Senn, DDS, University of Texas Health Science Center at San Antonio Dental School CERF, 7703 Floyd Curl Drive, San Antonio, TX 78229-3900*

After attending this presentation, attendees will understand the expansion of the WinID database to include identifiers in addition to dental that will improve efficiency and decrease workload of forensic investigators in Multiple Fatality Incidents.

This presentation will impact the forensic community and/or humanity by introducing WinID with an expanded database that will integrate identifying terms into one web based program. This will increase efficiency and decrease the workload for forensic investigators in Multiple Fatality Incidents. In addition, the program will be available to investigators from any location via the Internet.

The objective of this presentation is to 1) assess the impact of WinID's program expansion in Multiple Fatality Incidents (MFI's) via a survey of responders to previous MFI's, and 2) compile a comprehensive list of terms for identification to be incorporated into the WinID database to aid in identification efforts in MFI's.

A survey was taken of responders to previous MFI's requesting their input on the benefit of a program integrating all identifiers. This survey was conducted via the Internet. Identification terms were gleaned from existing forms used for this purpose, i.e., Victim Identification Profile (VIP), National Crime Information Center Missing Person Data Collection Entry Guide, and Interpol Victim Identification Form as well as terms added by the author.

Managing a Multiple Fatality Incident requires the collection of a large amount of antemortem and postmortem data. Organizing, accessing, analyzing, and making this data useful are challenges for forensic personnel. The expectation of positive identification of the victims is high. Scientific identification is typically based on one or more of four methods: dental, DNA, fingerprint and medically documented biological characteristics. Antemortem data that do not fall within these methods has the potential to be less useful, particularly in cultures that require identification to be scientifically based. Not every culture demands that a scientific standard be met for identification. A database that includes as many identifiers as possible would allow for applications in third world countries where the identification standards are different than those of the United States and may be based solely on personal effects or biological characteristics such as hair or eye color. The collection of antemortem data that includes only the most effective and most used parameters is becoming more of a concern. Misinterpretation of terminology by both interviewer and interviewee can hinder the identification process as well. Prior incidents have been worked using two well known but different software systems that are written in incompatible languages. WinID was designed to manage dental antemortem and postmortem data while VIP manages broader biological identifiers as well as personal effects. This arrangement requires investigators to be proficient in two different

programs to access all identifying data on an individual case. Surveys of responders to previous MFI's indicate that the integration of all antemortem and postmortem data would improve efficiency and decrease the workload of forensic investigators. This paper details a proposed single integrated web based software system, WinID that includes identifiers gleaned from forms already in use. The program will be written in ASP.net 2.0. The data will be formatted in Extensible Markup Language (XML). The XML format allows data to be accessed by programs using incompatible languages. It also allows for easy expansion and revision of terminology in the database if necessary. A single software system, an expanded version of WinID, would allow all investigators access to all data to improve efficiency in the identification of victims. In addition, having WinID web based allows easy access to the program online. The availability of the program online would allow for access by investigators from any location. This includes investigators onsite at the disaster as well as those off site that may be interviewing family members.

Forensic Odontology, WinID, Multiple Fatality Incidents

F18 Radiography 101 for NOMAD™

Allan A. Raden, DMD, MPH, 814 North Delsea Drive, Glassboro, NJ 08028*

After attending this presentation, attendees will have a greater scope of knowledge pertaining to the judicious use of radiographic equipment, specifically a self-contained portable X-Ray generator.

This presentation will impact the forensic community and/or humanity by providing general principles to be followed for safe and effective operation of radiographic equipment.

Emerging technologies in any scientific field can be a mixed blessing. Just because something is new does not mean that it is useful or appropriate for the desired application.

The analysis of dental remains has recently seen two new technologies; digital radiographic sensors and cordless radiation generating sources. While the general principles of dental radiography have not really changed since the move from a bisecting to a paralleling technique in the 1980s, newer, more powerful, faster and smaller X-Ray sources have made the job easier and more predictable. Whether the capturing device is an electronic sensor, phosphor plate, or silver based film, a reliable and safe radiation source is essential for successful evidence collection.

The introduction of the NOMAD X-Ray generating source has stimulated much discussion in the dental industry. The device is a self-contained, portable, and cordless hand-held unit capable of generating a quality X-Ray beam useful for dentists' purposes in the field as well as in the clinic or morgue. However, with this new device the user and others on the forensic team must be fully aware of its strengths and weaknesses. No instrument or device is a perfect tool, and, like a hammer, it can be very useful when used properly as well as very destructive if used improperly.

The purpose of this presentation is to familiarize the forensic investigator as well as the dental team in the proper use of this revolutionary device. Radiation hygiene must be respected in all cases because forensic dentists are frequently presented with adverse conditions in which to work. Discussion will focus on proper exposure technique, radiation safety, and team coordination. A review of basic principles of radiation generation and safety will be included to insure that all potential users can function with skill, accuracy, and safety.

A training protocol should be an essential element to familiarize the users with the technology and to maximize its potential. While dentists are all well versed in standard radiographic techniques, there still exists a learning curve that must be followed to insure efficacy and safety. The manufacturer's recommendations as well as field experience and application of basic physics could only benefit the forensic team in achieving speed, accuracy, and safety.

Radiation Physics, Morgue Team Performance, Digital Technique

F19 Aribex NOMAD™: A Useful and Safe Portable Hand-Held X-Ray Machine for Forensic Odontology?

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After attending this presentation, attendees will be able to assess the value of a portable X-Ray machine for use in forensic odontology and multiple fatality incidents.

This presentation will impact the forensic community and/or humanity by demonstrating how being portable and battery powered; NOMAD makes it easier for the operator to acquire images in virtually any position. NOMAD is a practical imaging system for forensic odontology. When teamed with digital sensors it facilitates film-less imaging that saves time. Consequently, the collection of postmortem information in multiple fatality incidents can be much faster and more efficient.

The Aribex NOMAD system is a handheld, battery-operated, portable imaging system. This presentation will describe major aspects of Nomad that is the latest development in portable X-Ray machines. Specifications of NOMAD will be presented (including physical properties, pictures and cross-sectional diagrams of the system). Several features of the NOMAD address the safety concerns. Understanding these features and the internal design of this system explains why it is safe for the operator and the public. The National Council on Radiation Protection and Measurements (NCRP) recommendations for annual operator exposure will be presented as well as the annual exposure values of Nomad used with film and digital sensors. NOMAD received the FDA's approval in July 2005. This device has been recently used in multiple fatality incidents after the Tsunami in Southeast Asia and after Hurricane Katrina in Louisiana and Mississippi. Details of its use in these disasters, safety issues and applications and digital sensor use with Nomad will be discussed. Operators in disaster morgue settings were instructed to wear protective gear, because safety was an important issue with heavy use of this machine. The supine position of the person being imaged required the operators standing near the gurney to be in an at risk position using a very new machine in a non-standard configuration. A brief comparison of image quality between the NOMAD and stationary X-Ray systems will be presented.

Methodology: Back scatter radiation was measured at different sites in the zone of significant occupancy (as defined by the IEC standard) within which the operator can be standing, once with the protective shield provided by the manufacturer, and once without the shield. Also, radiation leakage was measured at 11 different sites around the machine. Three measurements were taken, and the mean of these values was calculated. Data obtained will be presented, as well as zones of significant occupancy and the measurement sites for leakage radiation.

Discussion: Given the Leakage Radiation and Backscatter Radiation measurements at the instrument backplane, it is possible to estimate the maximum dose that would be received by an operator using the NOMAD. The typical whole body exposure to the operator can be estimated using the measured sum of backscatter and leakage radiation level at the control panel of approximately 1 mR/hr. Exposure to the hand is even more benign relative to the recommended exposure limits. The highest leakage data was 3.8mR/hr.

Conclusions: Radiation shielding inside NOMAD ensures that leakage from the X-Ray source itself is virtually eliminated, protecting the operator's hands and other areas close to the devices. The use of Nomad in its intended applications presents no more risk to the operator than using stationary X-Ray equipment. With moderate care, the operator can prevent any risk to the public. Image quality obtained by Nomad rivals that of stationary equipment, even when the X-Ray source is handheld,

particularly in cases using digital sensors with correspondingly short exposure times. Being portable and battery powered, NOMAD makes it easier for the operator to acquire images in virtually any position. Nomad is a practical imaging system for forensic odontology. When teamed with digital sensors it facilitates film-less imaging that saves time. Consequently the collection of postmortem information in multiple fatality incidents can be much faster and more efficient.

Forensic Odontology, Portable Dental X-Ray Machines, Radiation Safety

F20 Radiation Safety for the NOMAD™ Portable X-Ray System in a Temporary Morgue Setting

Kenneth P. Hermsen, DDS, Stanley S. Jaeger, MS, and Mackenzie A. Jaeger, Creighton University Medical Center, 2500 California Plaza, Omaha, NE 68178*

After attending this presentation, attendees will understand the radiation levels at various distances and angles that are generated by the NOMAD™ Portable X-Ray System and how these levels compare to established radiation safety guidelines.

This presentation will impact the forensic community and/or humanity by quantifying the radiation exposure to the dental personnel in the morgue at St. Gabriel utilizing the Nomad portable X-Ray unit. The amount of radiation exposure to the morgue personnel will be compared to established radiation safety levels to determine if additional safety measures are required to protect the dental team members.

The forensic odontologists who responded to the need for identification of the victims from New Orleans following Hurricane Katrina were pleased to find a new tool available to them at St. Gabriel. The new tool was a battery-powered, portable X-Ray unit called the NOMAD™. Sold and distributed by Aribex, Inc., the units performed exceptionally well. They proved to be a very valuable piece of equipment that had the portability and versatility required in the somewhat austere conditions that typically exist in a temporary morgue environment.

The radiation safety characteristics of the NOMAD™, reported by D. Clark Turner, Donald K. Kloos, and Robert Morten for the operator and the patient, were provided by Aribex in their promotional material. Their findings confirm that the radiation levels for the patient and operator are well within established radiation safety guidelines. However, their report did not consider the radiation levels for additional personnel that may be in close proximity to the NOMAD™ in a temporary morgue setting. In the morgue, since the patient cannot hold an X-Ray film or computer sensor in position, a second operator is required to perform that function. The morgue operation in St. Gabriel also made use of digital X-Rays so a third person was required to be present to operate the computer. Early in the operation at St. Gabriel, there were as many as three dental stations, each with three-person forensic dental teams operating simultaneously within the dental section. With that much activity, there is a need to quantify the radiation levels at various distances and locations to ensure that radiation levels to all personnel in the morgue are within the recommended radiation safety levels.

The author will present the results of an investigation of the radiation levels at various locations in proximity to the NOMAD™, using the location of personnel as they were positioned in the temporary morgue in St. Gabriel. A comparison will be made to the various radiation levels obtained in the study to the established radiation safety levels to determine the relative risk of radiation exposure to each member of the forensic dental team. The results will show that the level of radiation exposure to all members of the dental team were significantly below established radiation safety guidelines. Thus the use of the NOMAD™ at St. Gabriel presented no significant radiation risk to any member of the team.

Nomad™, Radiation, Safety

F21 Get Involved - Find the Missing

Peter F. Hampl, DDS, 7898 Greyhawk Avenue, Gig Harbor, WA 98335-4926*

After attending this presentation, attendees will be able to use the NCIC 2000 dental data base in cooperation with law enforcement to establish identifications in the largest mass fatality incidents facing this country.

This presentation will impact the forensic community and/or humanity by encouraging the forensic dentists of the AAFS to get involved with their local law enforcement agency to find the missing persons utilizing the NCIC 2000 dental database.

It has come to the attention of the author that the majority of law enforcement agencies in this country do not have a forensic dental consultant on staff. It is also evident that the forensic dental community has not approached the missing persons (antemortem) issue with the same intensity that is seen in the unidentified (postmortem) individuals. It is time that the forensic dentists get involved with their local law enforcement agencies. It is of paramount importance that the forensic dentists educate these agencies of the existence of the new NCIC 2000 dental database and how it works. If the law enforcement agencies do not buy into the NCIC 2000 dental database it is doomed to fail. The Missing/Unidentified Persons (MUP) situation is the largest **ongoing** mass fatality disaster in this country. In numbers alone it easily surpasses the most recent mass fatality disasters experienced by this country (September 11, 2001 and Hurricanes Katrina/Rita).

This discussion will outline the protocol used by the author to introduce law enforcement agencies to the NCIC 2000 dental database. However, before the forensic dentist approaches law enforcement he or she must be completely familiar with the NCIC 2000 dental data system. This paper will introduce this new system. The charting protocol, \$M reports and techniques in obtaining antemortem dental records will be explained.

The author has been approached by numerous forensic dentists asking, "How can I get more involved in forensic dentistry?" This is the ideal opportunity to get involved. The forensic odontologists of the AAFS already have the basic skills needed to tackle this problem. It is only a matter of directing efforts in the right direction to make a tremendous difference in this largest of all mass fatality incidents.

It is sincerely hoped that this presentation will encourage the forensic dentists of the AAFS to get involved in finding the missing.

NCIC 2000 Dental Data Base, Local Law Enforcement, Missing/Unidentified Persons

F22 Misidentification and Misinterpretation of Dental Evidence Recovered in Cremains

Peter W. Loomis, DDS, 3801 San Marcos NE, Albuquerque, NM 87111*

After attending this presentation, attendees will understand a technique of cremated remains examination and analysis and appreciate the need for a forensic odontologist to evaluate and interpret the dental evidence and the antemortem dental record.

This presentation will impact the forensic community and/or humanity by stressing the importance of an accurate interpretation of the dental evidence in cremains identification.

Cremated remains identification is a fairly uncommon request to forensic anthropologists and odontologists. Family members who suspect the cremains of their loved one(s) to be misidentified, commingled, or mislabeled are often the ones to make such a request for an examination and analysis to ascertain the cremains' identity.

Two cases of cremains misidentification will be presented, both of which have been litigated in civil courts. The cases involve cremations

done at different times by the same crematorium on cadavers that had been willed to a medical school. In both cases many dental restorations were recovered in the cremains.

Dental restorations and dental structures often survive the temperatures achieved during commercial, accidental, homicidal, or suicidal cremations. From the surviving dental evidence a comparative dental identification can often be made with the antemortem dental record to determine the identity of the cremains.

The first case involved the examination of cremains that were purported to be an elderly male who had willed his body to a medical school. Once the medical school had completed its study of the cadaver, a crematorium was contracted to perform the cremation, return the cremains to the medical school who in turn delivered them to the next of kin. The family had suspicions of the identity upon receiving the cremains because of labeling on the temporary urn, and media news stories relating to problems with the crematorium and medical school. An examination of the cremains done by an ABFO certified odontologist concluded the cremains were not those of the purported decedent. A second analysis of the cremains by an ABFA certified forensic anthropologist concluded the remains were "consistent" with the purported decedent and in a subsequent report stated that the cremains probably were those of the purported decedent. A third analysis was conducted by different ABFO certified forensic odontologist (the author), who concluded that the cremains were not the purported decedent. The presentation will focus on the dental evidence recovered, the antemortem dental records, the comparison between the two, and the misinterpretation of this evidence.

A second case involving the same medical school and crematorium will be presented describing a technique of cremains analysis and the recovery of non-biologic artifacts. As in the previous case, the dental evidence recovered does not agree with the antemortem record of the person purported to be the cremains.

The analysis of dental restorations and dental structures recovered in the cremains as well as the interpretation of the antemortem written and radiographic records should be done by a forensic odontologist. Dental nomenclature, dental anatomy, knowledge of restorations, materials, devices and clinical dental experience are needed to review the dental remains and antemortem dental record which are beyond the ken of a non-dentist.

Cremains, Identification, Dental

F23 Two Forensic Identifications Using the Grin Line Identification Method

Margery F. Friday, DDS, 27 Barkley Circle, Fort Myers, FL 33907*

After attending this presentation, attendees will learn the GLID system and its limitations and advantages during the discussion of two actual forensic identification cases.

This presentation will impact the forensic community and/or humanity by demonstrating to members of the forensic community the GLID system and how that system may be the only tool or an adjunct tool for the forensic odontologist to provide additional information to the medical examiner in identification cases within a small closed population group.

The goal of this presentation is to present two forensic identification cases utilizing the Grin Line Identification Method. This presentation is intended to inform the forensic community of the Grin Line Identification Method and its practicality in actual forensic cases.

Background: At the 2005 AAFS meeting in Seattle, a paper was presented on the Practical Application of the Grin Line Identification Method (GLID). The study tested the feasibility and practicality of using GLID in a medical examiner's office. The GLID method uses Adobe Photoshop software to compare antemortem and postmortem photographs. It was stated that GLID could be of value under the following circumstances:

1. A single or very small number of decedents require identification.
2. The decedent(s) having incomplete, inaccurate, or non-existent dental record/radiographs available.
3. Investigators are unable to identify or locate the decedent's dentist.
4. In missing children cases where antemortem photographs are available but where dental records/radiographs may not be compatible with the dentition at the time of disappearance.

Securing a good "smiling" photograph was one of the most important factors of this study. In addition, matching the photographic angulation between the antemortem and postmortem photographs was critical.

Objective:

1. To review the GLID system
2. To look at both the advantages and limitations of the GLID system.
3. To communicate and secure a good antemortem photograph from the NOK.
4. To examine the limitations and advantages of the GLID system.

Methodology:

1. Photograph the postmortem remains using a digital camera with a macro lens.
2. Photograph using varied projection geometry to increase the probability of matching the photographic angle of the antemortem photograph.
3. Obtain a variety of antemortem photographs from the NOK.
4. Obtain a consent form from the NOK.
5. Import both antemortem and postmortem photographs into a laptop via a card reader or scanner set at high resolution.
6. Use Adobe Photoshop to fabricate overlays of maxillary and/or mandibular teeth on the postmortem photograph.
7. Move the postmortem overlay(s) onto the antemortem photograph(s) for comparison using a variety of Adobe tools.

Conclusions: Using the GLID system to aid in the identification of two forensic cases provides the medical examiner with adjunct information. This information is very useful when combined with crime scene information and personal effects in identifying decedents in a small population group. In some cases the GLID system may be the only tool available to the forensic odontologist and, therefore, of value. At other times, it may be used as an adjunct tool when dental records/radiographs are non-existent, inaccurate or absent.

Forensic Odontology, Digital Photographic Comparison, Identification Method

F24 Antemortem Records: Assistance From the Forensic Odontologist

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After attending this presentation, attendees will understand the importance of retrieving antemortem dental records.

This presentation will impact the forensic community and/or humanity by assisting the forensic odontologist in locating antemortem records in difficult situations. A team effort to locate valuable antemortem records for identification must include the forensic odontologist.

When the forensic odontologist is requested to identify an unknown victim, antemortem records must be available for comparison to the postmortem records. The obtaining of these antemortem records often requires the assistance of the forensic odontologist as to where they may be found.

Recent mass disasters such as World Trade Center II, American Airlines Flight 587, and the Katrina 2005 Hurricane have all demonstrated the difficulties in obtaining dental antemortem records. Where to find records, collection, and their usefulness for identification purposes all provided the forensic odontologist with a major role to assist medico-legal

investigators, local and state police and governmental agencies for these tasks. Antemortem dental records of victims of the WTC II disaster have surfaced as many as four years after 9/11/2001. Antemortem dental records from unlicensed dentists who treated victims of AA Flight 587 were difficult to obtain. The destruction of dental facilities during the Katrina 2005 Hurricane made the recovery of the antemortem dental records a difficult task.

Forensic odontologists are faced in day-to-day operations at medical examiner's offices to make identifications and may often assist in the obtaining of sufficient antemortem data to complete the identification process.

In May 2006, a forensic odontologist was requested to do a postmortem examination on a victim found in a New Jersey river. Clinical examination revealed maxillary missing two central incisors, lost postmortem in the river and not recovered. One upper lateral incisor was missing antemortem. The significance of this situation could make a photographic dental identification difficult and more likely, not possible. Postmortem radiographs of the dentition revealed two teeth with root canal fillings, posts, and crowns; valuable information if the antemortem dental records are available. Photographs of the victim were taken by the medical examiner staff as well as a full head frontal X-Ray.

The mother of a 45-year-old male missing person was contacted by state police to provide information on where to locate dental records of her son. A dentist's name and telephone number was provided and given to the forensic odontologist. The possible victim's dentist was contacted and very cooperative with information on procedures he performed as well as recollection of the victim's dentition. However, this dentist had sold his practice to another dentist who when contacted stated that records over seven years old in his office were thrown away. Information was provided verbally by the dentist and was consistent with postmortem findings but hard evidence was lacking and identification could not be made at that time.

Communications between the Medical Examiner's Compliance Director and the forensic odontologist over the next three weeks eventually lead to the discovery of a head MRI series of radiographs including a lateral view showing teeth and a unique significant metal object in the orbit of the missing person. This same metal object was viewable on the postmortem frontal radiograph taken at the Medical Examiner's office.

The mother of a missing person supplied the name and location of a treating dentist, photographs of her son showing a smile that included the front upper teeth, and eventually supplied the information regarding an eye injury that ultimately was responsible for the identification of her son. The assistance of the forensic odontologist in locating antemortem records in difficult situations should not be overlooked. A team effort to locate valuable antemortem records for identification must include the forensic odontologist.

Antemortem, Postmortem, Dental Records

F25 Analytical Survey of Restorative Resins for Forensic Purposes: Elemental Composition and Microstructure

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The goal of this presentation is to provide the forensic community with a comprehensive survey of the elemental composition and microstructure of the prominent restorative resins on the market today. It has been demonstrated that restorative resins can be detected by elemental analysis and that they can persist and be recognizable even in extreme conditions such as cremation. Attendees will learn how knowledge of elemental composition and microstructure can help determine brand or

brand group of material used and how this information can be a valuable aid in identification.

This presentation will impact the forensic community and/or humanity by providing baseline data for comparison and classification of the prominent restorative resins currently on the market. Historical resins will also be discussed. The data produced is for reference and is in a form reproducible in laboratories worldwide.

Occasionally the odontologist will be called upon to identify a victim under difficult circumstances. Such circumstances include, but are not limited to, fragmented, or incinerated remains. In these cases the structural relationship of the dentition may no longer be intact, making traditional methods of identification problematic. In these situations, the odontologist should be aware of alternative means that can be available to aid in identification. One such method is the ability to recognize resin brand, or brand group.

In situations involving incineration, the amount of destruction will be dependent on the duration and heat of the fire. When a body has been incinerated to the point of cremation, all of the organic material is destroyed. When all that is left is fragmented calcined bone and teeth, identification can only be made from the non-biological artifacts that remain. It is well known that dental prosthesis will be recoverable from such extreme situations, but it is now established that dental resins are retrievable and still identifiable by brand name or group^{1,2}.

Resins are increasingly becoming the material of choice for dental restorations. Patient demand for esthetic restorations will ensure that this trend will continue. As a result there are currently over fifty resin brands on the U.S. market. Fortunately, the manufacturers vary their composition. Resins consist of several components, the principal of which are an organic matrix and inorganic filler particles. It is these filler particles that are resistant to heat and enable detection of resin brand, as the inorganic component will remain virtually unchanged even after being exposed to cremation conditions. This presentation describes the generation of a database of restorative resins that contains information about the unique properties of these materials.

For database generation, resins were prepared in 1cm discs and cured according to manufacturers' instructions. The discs were analyzed by scanning electron microscope (SEM), energy dispersive X-Ray spectroscopy (EDS), and X-Ray fluorescence (XRF). The discs were then placed in a burnout oven and exposed to a temperature of 900C for 30 minutes and the analysis was subsequently repeated.

The SEM produces images of high resolution, allowing detailed documentation of the resin microstructure. EDS analysis is performed concurrently in the SEM and an X-Ray spectrum is produced which represents an elemental fingerprint of the inorganic component within a sample. XRF is a separate analytical technique that similarly produces an elemental fingerprint. There are several distinct advantages in XRF over EDS in that the units can be portable, allowing them to be brought directly to the field.

The XRF can also detect trace amounts of an element, in the part per million ranges, and the spectrum is collected in a much quicker time, usually 6-10 seconds. The main disadvantage is that these portable units cannot detect elements lighter than phosphorus in the periodic table. In this database, both XRF and EDS spectra are presented, encompassing analysis by both methods.

The data produced by these methods was organized in database format utilizing software commissioned by the FBI³. The software is named Spectral Library Identification and Classification Explorer (SLICE). The database is maintained by the FBI and is thus available to the forensic community and can be queried as necessary.

When traditional methods of identification cannot be performed or show inconclusive results, then any alternative means can be of great importance. The ability to distinguish between resin brands or groups can add another level of certainty under these conditions. Under difficult circumstances the odontologist should be aware of the resources that are available. Knowledge that these analyses are possible and the baseline data provided here may aid in resolution when no other means is possible.

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Restorative Resins, Elemental Analysis, Identification

F26 Implications of Composite Resin Radiopacity During Dental Inspection

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After attending this presentation, attendees will gain knowledge of the variation in radiopacity of restorative resins. Their radiographic appearance in tooth structure will be discussed, and the potential for missing restorations during inspection will be assessed.

This presentation will impact the forensic community and/or humanity providing the forensic odontologist with a survey of the radiographic qualities of restorative resins, both historical and modern. This, along with preparation design is of significance because the ability to recognize restorations during dental inspection is dependent on the radiopacity, size, and location of the restoration.

Victim identification through dental record comparison relies substantially on radiographic evidence. Both clinical and forensic interpretation of a radiograph may involve distinguishing subtle differences in contrast and brightness in the image. Those small differences can reveal to the trained eye the presence of carious lesions, resin restorations or features such as veneers.

The combination of novel materials on the market and the trend towards esthetic restorations has resulted in placement of restorations that may be hard to detect both visually and radiographically. Since the inception of composite resins as restorative materials, their composition has undergone generational changes. Manufacturers have modified the composition of the resins for several reasons including shrinkage, handling characteristics, wear resistance, esthetics, and not least, radiopacity. Early resins used silica as inorganic filler, resulting in restorations that appeared radiolucent. Today most (but not all) manufacturers have incorporated heavy elements in the fillers that strongly absorb X-Rays. The result is that a person of middle age is likely to have an assortment of restorative materials in the dentition, which will present differently radiographically.

In dental X-Rays, exposure conditions and film sensitivity are optimized to reveal structural features of bone, root, dentin, and enamel. Metal objects are at or near the limit of the dynamic range of the recording medium, and therefore appear as featureless radiopaque objects with no internal structure.

Resin alone is radiolucent, but with the addition of heavy elements can be made more radiopaque than enamel on a volume to volume basis. Indeed, the current trend is to ensure that the resin has a radiopacity equivalent to more than 3mm of aluminum, which exceeds enamel in an equivalent volume. Thus, today's resins are more radiopaque than enamel, and many times more so than dentin.

It is when a restoration is placed solely in enamel that detection becomes difficult. When the restoration extends into dentin, the clinician can easily recognize the intrusion of the more radiopaque material into the comparatively radiolucent dentin. Molar occlusal surface preparations, for example, may not be visible because that area of a radiograph may

already show high radiopacity. In addition, the trend towards minimally invasive dentistry and preventative restorations may result in smaller and thinner restorations than were previously placed. The improved modern bonding techniques allow placement of small amounts of material without deep preparation. Even these small alterations form part of the uniqueness of the dentition, however, and they are therefore of importance for forensic identification.

In this study, the radiopacity of modern and historic resins was measured. Discs of resin 1cm in diameter and 1.7mm thick were prepared according to manufactures instructions. Slices of human dentin and enamel also 1.7mm thick were used as a control. For some of the historical resins it was found that the curing initiator was no longer active. In these cases it was possible to press a disc of the correct thickness bounded by a ring mold. A Nomad portable X-Ray unit was used as a source, and a Schick digital sensor was used to collect the radiographs. Exposure was optimized and a calibration curve was produced using increasing thicknesses of aluminum. The relative radiopacity of the resins was plotted using the gray level of the resin in the radiograph.

The results show that with one exception all the modern resins are significantly more radiopaque than the equivalent volume of enamel. The exception was Gradia (GC America), a product developed in Japan, in which country heavy elements in resins are not permitted. The flowable resins showed less radiopacity than their packable counterparts. The most radiopaque resins contained the highest atomic number elements in their filler particles. Particle size and filler loading also affected the radiopacity. These characteristics are described in a concurrent presentation.

The historical resins fell into two groups, one much less radiopaque than enamel, and one more radiopaque. The less radiopaque group contained silica as filler.

Examples of conservative restorations using modern resins were examined in order to ascertain their visibility in radiographs. Radiographs of unrestored, prepared, and restored teeth showed the potential difficulty of detection of these restorations, despite the increased radiopacity of modern resins.

In this presentation the radiopacity of modern and historical resins is measured and aspects of their detection in the dentition are explored. The continuing development of restorative materials demands that the effect of new formulations on resin characteristics is understood. Similarly, the trend towards minimally invasive dentistry should alert the inspecting practitioner to expect more subtle evidence. As radiology is a key part of the forensic dental inspection, it is important to recognize potential limitations.

Radiopacity, Restorative Resins, Identification

F27 Ultraviolet Illumination as an Adjunctive Aid in Dental Inspection

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After attending this presentation, attendees will gain an understanding of practical aspects of dental inspection using ultraviolet light. They will understand the differences in fluorescence properties among various restorative materials, and appreciate how this information can help identify unknown individuals.

This presentation will impact the forensic community and/or humanity by demonstrating the potential of fluorescence as a property that can be used to detect materials that might otherwise be missed during postmortem dental charting.

The clinician is presented with a large array of restorative materials on the market today. The popularity of these materials is reflected in the fact that there are currently over 50 brands of restorative resins alone. Materials have been developed which have shade and translucency that can be virtually indistinguishable from tooth structure. The increasing use of esthetic materials in dentistry presents a challenge to the clinician and the forensic odontologist alike. Manufacturers have achieved their esthetic goals, but have created a problem for easy visual detection. Furthermore, radiographic recognition may also be difficult as the contrast between tooth structure and restoration is sometimes similar.

As placement of these materials becomes more common, the ability to recognize their existence and to chart their presence becomes important, especially in forensic situations. All restorations form part of the uniqueness of the human dentition. The presence of a specific material on a given tooth surface may be a significant concordant point in victim identification.

Alternative light sources have been used with success in various fields of forensic science. It was one goal of this research to quantitatively assess the fluorescent properties of modern restorative resins in order to predict their behavior during inspection. The second goal was to demonstrate practical use of UVA light in dental inspection with examples of how different materials fluoresce.

The intensity of fluorescence and the excitation and emission spectra of fifteen composite resins were quantitatively measured. All fifteen resins were prepared according to manufacturers instructions and cured in 1cm discs. In addition, sections of enamel and dentin were prepared in order to compare the fluorescence properties of tooth structure to the resins. Spectroscopy was performed using a laboratory fluorimeter.

All of the composites fluoresced. The composites could be organized into three categories: highly fluorescent, moderately fluorescent, and weakly fluorescent, based on the intensity of light emission. Enamel and dentin also fluoresced. Dentin fluoresced most strongly of all samples, and it was found that some resins fluoresced more intensely than enamel, while some were less intense. In both cases, inspection would reveal contrast between the resin and tooth. Some of the resins exhibited fluorescent properties very similar to tooth, however. If these resins had been placed, they would not be detectable by this method. In such cases, recognition of these resins would depend on their radiopacity.

A UVA light source was also used to inspect the dentition of several unidentified individuals. A number of features were revealed by this method. Some resins fluoresced blue while others were yellow. Even very small restorations were made visible. Some obvious resins did not fluoresce, however. It was also found that porcelain-containing restorations varied considerably in fluorescent properties, from very dark to very bright. Veneers were detected by this method that were difficult to observe visually.

The speed of inspection with a light source warrants use of this technique as an adjunctive means of inspection, as the majority of these restorative materials will be made visible. This is especially appropriate in situations where many bodies are to be screened.

The greater likelihood of encountering esthetic materials in modern dentitions demands that their presence is anticipated. Any means of gaining additional levels of certainty in victim identification should be exploited. This study underlines the critical need for careful record keeping as the complexity and variety of restorative materials broadens. As custodians of records that, although not anticipated, could help to prove a victim's identity, the clinician has a responsibility to select restorative materials that, based on fluorescence, could be used to aid in positive identification.

Fluorescence, Identification, Dental Materials

F28 A Brief Discussion of the Formation of the National Disaster Mortuary Team (DMORT)

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The goal of this presentation is to show how the loss of a U.S. Coast Guard (USCG) ship, the Cuyahoga precipitated (in part) the formation of a national disaster team. The quest that eventuated in DMORT will be briefly discussed.

This presentation will impact the forensic community and/or humanity by highlighting the evolution of and formation of DMORT.

At 9:00 a.m. on October 29, 1978, the USCG ship *Cuyahoga* was struck by an Argentine coal freighter *Santa Cruz II*. The Coast Guard ship sank within minutes in 58 feet of water. Eleven crewmen were lost. This accident, along with previous occurrences caused the Coast Guard to realize the need for a specially trained group of personnel to deal with disasters. Due to the concentration of families with losses and casualties, morale was severely affected. The USCG formed a casualty assistance response team (CART). CART outlined the various personnel and other federal services that would be needed in disasters or large emergencies. This outline and document was approved in April 1979. The U.S. Navy was asked to assist in the endeavor. There were problems as the USCG is under the Department of Transportation (DOT) and the Navy is under the Department of Defense (DOD). A memorandum of understanding (MOU) was initiated by the Navy, which outlined how they would help in the event of a disaster or large emergency.

In July of 1983, Dr. Everett Koope, the U.S. Surgeon General, requested a plan for a dental forensic team to be used in mass disasters. The request was given to Dr. Robert Mecklinburg who was the chief dental officer of the U.S. Public Health Service (USPHS). Dr. E. D. Woolridge, serving in the USPHS, was chosen to serve as project manager. Two other individuals were also appointed. They were to write a position paper with the advantages and disadvantages of using a dental forensic team in disasters or large emergencies. This initial plan was submitted in the fall of 1983. In 1989 the USPHS requested a plan for a dental forensic team for mass casualty events and disasters. Dr. Woolridge and his team conferred with members of the American Board of Forensic Odontology (ABFO), members of the American Academy of Forensic Sciences (AAFS) and interested faculty with forensic training and backgrounds at various dental schools in the U.S. and Canada. They also met and had discussions with dental practitioners who also did forensic dentistry. Their final plan was submitted on 9-30-89 and approval came one month later. A MOU between the oral and maxillofacial pathology department of the Armed Forces Institute of Pathology (AFIP) and the USPHS was developed.

In the early 1980s a committee was formed within the National Funeral Directors Association (NFDA) to address disasters and the resulting mass fatalities that had occurred. This group had difficulty in small and larger disasters previously due to a lack of standardization in both methods and approach to these disasters. In these disasters the initial response was from funeral directors, but it was soon apparent that the job was too large to handle due to the federal, state and local problems they encountered. As a result of these situations the NFDA formed a non-profit organization open to all forensic practitioners. The NFDA also designed and purchased the first portable morgue for a national level response. After a series of aircraft crashes and other similar disasters the families of the deceased demanded and received a response from Congress. The Family Assistance Act was passed in October 1996 that required all US-based airlines (and was amended later to include all carriers operating in the US) to assist families in case of an accident.

Ultimately, because of the effort of the NFDA and the USPHS and other interested forensic scientists DMORT was formed. It was initially

under the direction of the Department of Health and Human Services (DHHS) and then was transferred to the Department of Homeland Security and at present is under the auspices of Federal Assistance and Management Association (FEMA). The U.S. and its territories have been divided into regions, each of which has active training of the members to be able to respond to a call to action in the event of a disaster. DMORT has over 1,200 trained individuals in all regions of the U.S. ready to respond when ordered. Under the direction of the late Tom Shepardson, DMORT is now well organized and ready to respond. Evidence of this response was shown in the hurricane that struck the gulf coast recently. The dental section of DMORT made all examinations, radiographs, and identifications in a digital fashion with no paper or film involved.

Disasters, Fatalities, Planning

F29 An Overview of the Certified Emergency Manager (CEM)

Jane A. Kaminski, DDS, 13204 East Outer Drive, Detroit, MI 48224*

After attending this presentation, attendees will gain knowledge of the CEM designation and understand its importance for effective emergency response.

This presentation will impact the forensic community and/or humanity by assisting attendees to see the need for extensive cross training to deliver a timely response post-incident.

Events of the recent past have shown the worldwide vulnerability to both man-made and natural disasters. The post-incident response and recovery of the affected area involves differing areas of expertise. Coordination between multi-agency responders ensures affective and timely resolution of the event.

The Certified Emergency Manager (CEM) designation is an internationally recognized certification. Emergency management today has a comprehensive, all-hazards, and risk-based approach to all phases of an emergency: mitigation, preparedness, response, and recovery. Public and safety and the fire service are no longer the sole leaders in emergencies.

The National Response Plan (NRP) and the enactment of the National Incident Management System (NIMS) dictate minimum standards for training. The requirements of the CEM program and certification satisfy these parameters. NIMS compliance is especially important to jurisdictions that rely heavily on funding from the various Department of Homeland Security grants.

The applicant needs a minimum of three years of emergency management experience. Actual disaster response or participation in full-scale exercises will satisfy this requirement. The applicant also needs any four year baccalaureate degree. In some circumstances, additional experience may be substituted. Three professional references are required as well as one from a current supervisor.

One hundred hours of continuing education is required in emergency management. General management training has a minimum of one hundred contact hours. The caveat to these requirements is that no more than twenty-five percent be in any one topic.

The applicant must be able to prove that he or she has made a personal investment to the emergency management profession. There must be six different contributions to satisfy the CEM requirements. Acceptable submissions may include professional membership, speaking engagements, and publication. The individual may include service on a volunteer board such as a LEPC (local emergency planning commission), if it is not part of the applicant's day-to-day work activities.

The ability to oversee and respond to a real-life scenario is based on the applicant's essay. This essay, consisting of approximately 1000 words tests the individual's ability to integrate their knowledge and skills to deliver an effective outcome.

The application is then reviewed in its entirety by the CEM commission as to its acceptability. If all requirements have been successfully fulfilled the candidate is eligible for the exam. The multiple-choice exam consists of one hundred questions encompassing all four phases of emergency management. A minimum score of seventy-five is needed to pass the exam.

Certification as a CEM is for a five-year period. At the end of this interval the CEM must submit documentation for re-certification. In this time, the individual must show one hundred hours of continuing education with seventy-five hours in emergency management and twenty-five hours in general management training. Proof must be shown for six additional contributions to the profession since the last certification.

The complexity of disasters such as Hurricane Katrina and the World Trade Center preclude a multi-agency response. The integration of the separate entities is vital to attain an effective and timely response with little duplication of effort. The CEM program is a means to credential individuals who will pursue these objectives.

Certified Emergency Manager, National Incident Management System, Disasters

F30 Disaster Victim Identification in a Global Community: Issues and Challenges

Eddy De Valck, DDS, DVI Team Belgium, Parklaan 10, Beigem, B-1852, Belgium*

After attending this presentation, attendees will learn about the qualifications, protocols, and procedures needed for adequate disaster victim identification that can withstand scrutiny of international legal systems.

This presentation will impact the forensic community and/or humanity by demonstrating that the only good way to obtain maximum results in disaster victim identification operations is to work according to standardized protocols and procedures that have to be accepted and applied by all involved, regardless of personal agendas and opinions.

The Asian Tsunami of 26 December 2004, which caused over 200,000 casualties in more than 10 countries in and around the Indian Ocean, was a prime example of how in a global community an international interdisciplinary disaster victim identification operation was set up and coordinated. This was accomplished by the Interpol Secretariat General and DVI Standing Committee in Lyon according to the Interpol philosophy (DVI). DVI teams from more than 20 countries took part in the identification process which, because of the complexity of the situation and different legal systems, had to be conducted in an internationally agreed upon way.

Despite existing protocols and procedures the biggest challenge turned out to be quality control at all levels of the operation. After a thorough review by Interpol a good number of issues were identified and discussed at the annual Standing Committee Meeting in Lyon. The challenges for the future will be to create a unified front and get all pointed in the same direction regardless of personal agendas and interest.

Forensic odontology, being one of the primary identifiers, faces the same issues and challenges overall. A review will be given and some suggestions for future practice will be made.

Disaster Victim Identification, Interpol DVI Philosophy, Forensic Odontology

F31 The Dental Identification of the Swedish Tsunami Victims in Thailand

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After attending this presentation, attendees will understand the complexity of the identification procedures when the victims and the identification teams come from more than 30 nations.

This presentation will impact the forensic community and/or humanity by describing an unprecedented effort in peacetime - the identification of more than 5000 victims of the tsunami disaster in Thailand. Identification teams from more than 30 nations cooperated in the identification work, which was coordinated by the Interpol. It took more than a year, resulting in the successful identification of nearly 90 % of the victims.

Background: On the morning of December 26, 2004, a 9.5 earthquake occurred under the seafloor in the Bengal Bay, off the coast of the Indonesian province of Banda Aceh. The earthquake displaced enormous quantities of water, which moved toward the surrounding coasts turning into giant Tsunamis as the waves neared land. The disaster hit Indonesia first causing the death of nearly 200,000 people. The coastal areas of other countries around the Bengal Bay were devastated later as the Tsunamis spread. Sri Lanka, India, and Thailand were the countries second in the path and thousands of people lost their lives there. Hours later there was also loss of life as far away as the Maldives and the east coast of Africa. Among the more than 5000 victims of the Tsunami disaster in Thailand about half were western tourists and 543 of them were Swedish. This was the greatest mass disaster that had affected Sweden since the Estonia ferry disaster in 1994, when several hundreds of Swedish citizens lost their life.

Aims: The aim of this presentation is to describe the complexity of the work of identifying the victims of the Thai Tsunami Disaster.

Material and Methods: The task of identifying the deceased was undertaken by the identification teams from 32 countries. The *antemortem* (AM) data were gathered in the home countries and sent to Thailand. The *postmortem* (PM) investigations were conducted in the makeshift morgues on several locations around Kaolak, Phuket, and Krabi areas. The AM and PM information was inserted into the Interpol Disaster Victim Identification Program (DVI), which was put up in a computer network at the Thai Tsunami Victim Identification Information Management Center (TTVIIMC) in Phuket, Thailand. Experts from all disciplines were involved in the identification work. The National Board of Forensic Medicine sent out 50 experts during the year that the identification effort was carried out. Twenty-nine of them were dentists, working both in the Home Commission in Stockholm, Sweden, collecting and transcribing the dental records of the missing persons into the DVI database, as well as in the field gathering the PM information that included the description of the dental status, photographs and dental X-Rays. Many dentists were also involved in the TTVIIMC in Phuket, where they made transcriptions of dental records into the computer system and conducted reconciliation work (search and comparison) matching the AM and PM records.

Results: Whereas most of the Thai victims of the Tsunami were identified by fingerprinting, the majority of the western victims were identified by dental comparison alone (around 80 %), and in another 10 % of the cases the dental matching played a significant role in the identification process. Out of the 543 Swedish victims, 528 have been identified, 374 of them by dental status alone. Another 55 have been identified by a combination of methods including dental comparison.

Conclusion: Dental identification requires a great amount of manpower when many victims are involved, but it is a swift and extremely reliable means of identification of human remains. In the case of the Tsunami disaster the forensic odontology proved to be the most useful discipline in the identification process of the western victims.

Tsunami, Mass Disaster, Dental Identification

F32 Maxilla Removal: The Best Technique to Achieve Dental Identification?

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After attending this presentation, attendees will understand how maxilla removal is easy to realize and aids in victim identification.

This presentation will impact the forensic community and/or humanity by assisting attendees in considering maxilla removal as a classic technical and not as an abnormal practice.

Identification has only one purpose; give a body the right identity. Therefore the expert has to insure that all of the conditions are present to reach the truth.

Considering the dental identification, charting has to be done the most accurate way possible and all the further examinations performed in good conditions.

The French presence in Thai Tsunami Victim Identification process from January to June 2005 allowed researchers to draw the conclusion from this common work.

Two periods can be described; January 2005, when it was possible to remove both maxilla and mandible, and after January 2005, when only the mandible sampling was permitted.

The conclusions from the Tsunami experience were:

- Dental charting was often was difficult when the maxilla wasn't removed.
- Maxillary X-Rays were difficult to take because of the same conditions.
- Cleaning and photographing non-removed specimen weren't good enough.
- Many teeth were lost or impossible to find on/in dead bodies and body bags.

Therefore, observing numerous incomplete or imperfect autopsies, quality control led to numerous re-examinations; consequently losing precious time both for the families and the experts.

Previous experiences in France provided the opportunity to apply the AFIO (French Association for Odontologic Identification) standard, which is mandatory maxilla and mandible removal in disaster victims identification.

The first experience is the "Ordre du Temple Solaire" massacre. Sixteen persons were shot and partially burned, including adults and children. The removal of maxilla and mandible allowed systematic orthopantomograms, very helpful for children age estimation and in many cases for comparative studies.

In the "Essoye disaster", 8 victims died in a house fire. Maxillas and mandibles were resected, orthopantomograms taken and, in the same way as the previous case, children age estimations and comparative examinations were completed.

For the "Concorde crash", 113 bodies were examined. Maxillas and mandibles were removed and for the first time, the samples were stored apart in plastic boxes. Obviously the boxes were clearly labelled. The perfect quality of the antemortem data, collected by German Police, allowed 112 identifications without any postmortem X-Rays.

In the "Tunnel du Mont-Blanc fire", which involved 39 victims, most of the bodies were very severely destroyed. Only five bodies were complete and for those one maxilla and mandible were removed.

The purpose of this work is to summarize the main different experiences of the French experts for the last 10 years.

In the researchers' opinion, and according to International Organization for Forensic Odontology recommendations for disaster victim identification, it seems essential to remove both maxilla and mandible.

This removal is necessary to clean, handle and examine accurately the anatomical pieces. The dental chart is completed without any missing detail and a standardized photographic protocol can be applied. Radiographies under any angle can be taken without danger. The radiographic data can be completed with orthopantomograms.

The storage is easy using plastic boxes that can be kept in the body bags, avoiding the loss of any evidence and permitting re-examination in better conditions.

The moral aspect is obvious, but where is ethics; leave a body unidentified or do everything to succeed? Can the best technique to achieve identifications be avoided?

Victim Identification, Maxilla Removal, Forensic Odontology

F33 Alligator Bites: Déjà Vu

Kenneth F. Cohn, DDS, Office of the Medical Examiner District 5, 809 Pine Street, Leesburg, FL 34748*

After attending this presentation, attendees will understand an applied methodology for analyzing animal (alligator) bite marks.

This presentation will impact the forensic community and/or humanity by examining and analyzing animal bite marks.

The range of the American Alligator (Alligator Mississippiensis) extends from the coastal swamps of the Carolinas to the tip of southern Florida, west along the Gulf Coast to the mouth of the Rio Grande. Alligators live in freshwater lakes, rivers, swamps, and brackish water. In competition, Florida's human population, currently at 12.5 million, is increasing by upwards of 900 a day. Urbanization of traditional alligator habitats has led to increased encounters of the dangerous kind.

Issues of non-cohabitability are reflected by the thousands of alligator related complaints received by the Florida Game and Florida Fish and Wildlife Commissions. During the 51 year period between 1948 and 1999, 419 alligator attacks on humans were documented with 10 of those resulting in fatalities. Contrast that to the 5 years from 2000 to 2005 when there were 107 reported alligator bites and seven fatalities. During the first half of 2006 there were an additional three deaths. Although the number may seem small the trend is problematic of ever increasing contact between the indigenous alligator population and humans.

This presentation will illustrate the cooperative effort between the Florida Fish and Wildlife investigators, Medical Examiner's staff, and the forensic odontologist in determining the identification of alligators' responsible for the deaths of two individuals based on traditional dental bite mark analysis.

The first case involved a 12-year-old male who was attacked and killed while playing with friends along a riverbank in Central Florida. The attack occurred near dusk and was, according to the investigative report, provoked by harassing the animal. Examination by the Medical Examiner showed near traumatic amputation of the left hand as a result of a bite at the wrist, avulsion of a large gluteal area and numerous contusions, skin tears and bite marks of the extremities, head, and torso. Cause of death was drowning. Trappers collected nine suspect alligators in the geographic region of the attack. The wildlife biologist dissected the heads and separated the jaws. With the victim on the gurney, the alligator dentitions were compared directly to the bite mark wounds on the victim's body. Eventually, one large male alligator measuring 10'6" and weighing 337 pounds was identified based on a positive match of the dentition directly to the bite mark wounds.

The second death occurred when a 23-year-old female was killed while snorkeling in a freshwater spring, also in Central Florida. The cause of death was drowning. She sustained bite marks, contusions, and injuries to the head, chest, abdomen, and arms. A large 11'5" 407 pound male alligator known to reside in that area was captured and brought to the Medical Examiner's office for evaluation. The victim had been released to the family and was not available for direct comparison of the dentition to the wounds. As a result, the more traditional bite mark analysis was

utilized. The alligator dentition was duplicated in Alginate impression material and poured in dental stone. The models of the teeth were scanned on a flatbed scanner and imported into Adobe Photoshop 7. Photographs of the bite marks were sized 1:1, also in Photoshop, and a bite mark comparison was conducted. A successful identification was established.

In addition to the two cases presented by the author, four other fatalities caused by alligators have been reported in Florida in 2006. Cooperation between the Medical Examiner, Florida Fish and Wildlife investigators, and the forensic odontologist has resulted in the identification and removal of several dangerous and aggressive alligators from the population. This is not to suggest that alligators, by their very nature, are human predators and need to be eliminated. The circumstances involving negative interaction between humans and alligators appear, for the most part, to be accidental, protective, or provoked. People need to be respectful of the potential hazards and use common sense when encountering alligators.

Alligator Attacks, Forensic Odontology, Animal Bite Marks

F34 The Mother of All Multi Bite Marks

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After attending this presentation, attendees will understand the management of multiple bite marks on a victim.

This presentation will impact the forensic community and/or humanity by providing knowledge via case presentation.

Learning Objective: This is an exercise for the attendee odontologist to select the appropriate level of identification terminology from the ABFO bite mark guidelines he or she would choose as compared to the choices of the presenter.

Outcome: Bite marks not only have their own forensic value, but can prompt law enforcement creativity to use other investigative techniques to build a case.

This case is unusual in that there were multi-bite marks on the victim, done over a multi-period of time, with multi-suspects, in multi-jurisdictions resulting in multi-criminal charges, and involving multi-forensic odontologists. At the time it was called the worst case of child abuse ever seen in Jacksonville by involved authorities.

A ten-month-old black female was hospitalized in pediatric intensive care with multiple fractures including skull and arm; cellulitis, particularly on the face; and a large number of patterned injuries, many superimposed over each other, in different stages of healing. With the infant on intensive care support a team of nurses and police manipulated the victim so as to obtain reasonable bite mark photography under the circumstances. The infant eventually recovered and was placed in foster care by the State.

While the photographs were deemed suitable for comparison, the challenge was the decision making under ABFO guidelines as to the status of each injury pattern and whether each was suitable for comparison, and at what level. At the request of the odontologist, medical examiners viewing the photographs timed the bites as from 6 days to 6 weeks old, or more. None were timed as "recent," meaning over the last few days.

The only suspect at the time was the mother who had been in Florida for about a week, and who was being held on child neglect charges, having been seen by neighbors carrying the infant around for days in this condition. The mother's dental exemplars were taken by court order. No evidence of her peg upper laterals were seen in any curvature deemed a "possible" or a "probable" bite mark and the odontologist ruled her out as a biter, so that charges against her stood as "neglect" rather than "abuse."

While in custody, the mother maintained the abuser/biter was the purported father who remained in the adjacent state of Georgia, and whom she had left about a week before coming to Florida. Since the incarcerated mother remained in phone contact frequently with the father, detectives in

Jacksonville began working with the Georgia Bureau of Investigation (GBI) agency in Adel, and, with the mother's cooperation, a legal phone recording strategy was initiated to help build probable cause for taking his dental exemplars.

So as to limit travel time and expenses, the Florida odontologist enlisted the help of a dentist in Adel Georgia, and sent him certain dental materials for use in the protocol for taking evidence from the suspect. Having developed probable cause, the GBI served a search warrant on the suspect and the enlisted dentist obtained the inventory requested. The GBI delivered the inventory to the Florida odontologist via chain of custody through the Jacksonville Sheriff's office.

The father's exemplars were compared to the only two certain human bite marks deemed suitable for comparison for a higher level of identification.

There was evidence of intentional alteration of certain teeth as seen in the models of the father's teeth, particularly the incisal embrasures of the lower anteriors.

The odontologist was not able to demonstrate a material difference between the real bite marks and test bites in skin using the models taken during the search warrant which would have been after intentional alteration.

Bite Marks, ABFO Guidelines, Intentional Alteration

F35 Looking to the Future: Opportunities for Research in Forensic Dentistry

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After attending this presentation, attendees will learn the results of a research study designed to determine specific research topics that need to be studied to increase scientific knowledge in the field of forensic dentistry. The attendees will be presented with a list of specific research questions that they may consider when planning new research studies of their own, and will be presented with information on obtaining grant funds to implement their future research efforts.

This presentation will impact the forensic community and/or humanity by providing practical and timely information about the research topics that are considered to be the most relevant to the field of modern forensic dentistry. It is anticipated that the presentation of the results of this research and study will serve to stimulate an increase in the quantity and quality of future research conducted in the field of forensic dentistry.

This research study is the work of the members of the Research Committee of the American Board of Forensic Odontology. The study was conducted in an effort to encourage researchers to conduct scientific studies on topics of importance to the forensic dental community by giving them ideas for studies to conduct, as well as providing them with information on funding sources available. It was conducted in a concerted effort to stimulate the increase in the quantity and quality of research conducted in the field of forensic dentistry. Prior to its implementation, this research project was reviewed and approved by the Committee for the Protection of Human Subjects of the University of Texas Houston Health Science Center as HSC-DB-06-0377. All responses were grouped and no individual was identifiable, thus all responses were completely confidential.

Respondents to the survey, members of the American Board of Forensic Odontology, were asked to rank a list of eight general research topics in their order of importance. The respondents were next asked to list specific research questions that they felt would be important areas to study in each of the eight general topics. Two of the topics stood out as being the most important areas in need of future study. The field of

patterned injury/bite mark analysis was ranked as the area most in need of modern research data, with the field of dental identification a very close second. The remaining topics in order of most need for further research were ranked in the following order of importance: mass fatality incident management, person abuse, expert witness consultation and testimony, age determination, dental jurisprudence, and facial approximation.

Specific research questions that respondents felt would be important to study in each of the eight listed general research areas were compiled, and a small sampling of them follows. A more detailed analysis of the survey results will be presented during the scientific session's oral presentation.

In the area of patterned injuries and bite marks, respondents felt that the following specific questions would merit further research data: 1) what is a quantitative measure of the individuality of the human dentition; 2) how might pain from a bite mark be measured for legal purposes; 3) studies on three-dimensional analysis of bite injuries; 4) studies on the validity of bite mark analysis; 5) confidence levels in analyzing bruise marks from any source; 6) develop a database of large populations to give statistical relevance of tooth position and dental anomalies; 7) can techniques such as transillumination and alternate light source be proven valid in a large group of observers?

In the area of dental identification, respondents felt that the following specific questions would merit further research data: 1) tooth morphology in reference to race determination; 2) degree of certainty of identification of test cases; 3) do computer aided methods of dental record comparisons really save time in the long run over traditional manual methods; 4) factors other than radiographic that forensic dentists use to perform dental identifications; 5) are individuals truly unique dentally; 6) reliability of dental identifications using only orthodontic models; 7) value of digital radiography vs. traditional dental film.

In the area of mass fatality incident management, respondents felt that the following specific questions would merit further research data: 1) the role of the forensic dentists in incident management at all levels; 2) development of a psychological test specific to forensic dentists for the impact post traumatic stress after a mass incident on experienced vs. less experienced dental personnel; 3) comparison of results of DNA analysis vs. dental information during a mass fatality incident.

In the area of person abuse (child, elder, and spousal), respondents felt that the following specific questions would merit further research data: 1) comparison of issues common to child, elder, and spousal abuse; 2) the incidence of abuse reported in dental offices; 3) current demographics of abusers and those abused; 4) frequency of reporting elder abuse in institutional vs. private care facilities.

In the area of expert witness consultation and testimony, respondents felt that the following specific questions would merit further research data: 1) how is an expert witness defined in different jurisdictions; 2) study on trial aids used during testimony; 3) data on fees charged by forensic dental consultants in various regions.

In the area of age determination, respondents felt that the following specific questions would merit further research data: 1) dental differentiation of age among various races; 2) reliability of occlusal wear in age determination; 3) third molar root development; 4) age of majority among different jurisdictions; 5) use of dental age determination for legal purposes, i.e. immigration; 6) reliability of hand/wrist radiographs vs. dental radiographs.

In the area of facial approximation, respondents felt that the following specific questions would merit further research data: 1) data on how forensic artists and forensic anthropologists determine facial approximation; 2) with what frequency does facial approximation result in identification of an individual.

In conclusion, this survey of experienced forensic dentists revealed a wide range of suggestions for research questions that merit exploration through scientific investigation. A thorough analysis of the survey results and suggestions for funding sources will be presented during the scientific session's oral presentation.

Forensic Science, Forensic Dentistry, Research

F36 After 14 Years, A Suspect Finally Receives the Death Sentence for the Killing of a 9-Year-Old Child

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After attending this presentation, attendees will understand how teamwork is essential between forensic experts, law enforcement investigators, and prosecutors in solving cold case homicides such as this one.

This presentation will impact the forensic community and/or humanity by demonstrating the principles listed above.

On June 17, 1991, a 9-year-old child was kidnapped from her home in Chula Vista, a city just south of San Diego. Her name was Laura Arroyo. She died as a result of "multiple chop wounds of the head, multiple stab wounds of the chest and abdomen, and asphyxiation." She had answered a doorbell at her residence while her parents were upstairs. When she did not return, her parents found the front door open and there was no trace of Laura at 9:00 p.m. Early the very next morning, two women arriving at work at a Chula Vista business complex found her body fully clothed, face-up on the sidewalk. Underneath her body, investigators found triangular depressions in the cement sidewalk. These depressions were directly under her left chest, which displayed eight through-and-through injuries. In one of the injuries, medical examiners found the front of her pajamas deep into the wound, indicating that whatever implement caused the injuries was not particularly sharp because the material was not pierced. Over the frontal bone fractures were various lacerations, approximately two inches in width.

The murder weapon was never recovered in the searches at the crime scene or at the residence of an early suspect. Blood splatter on ceiling supports close to the victim indicated that the homicide had occurred where the victim was found. Shortly after, at the autopsy, swabbings taken from the child's body and clothing were transferred to microscope slides. Apparently, there was not a complete transference of the material and no DNA indicators were recovered. The case eventually became a cold case until 2003, when a San Diego Police Department criminalist, employing a new sophisticated DNA technology, re-examined the evidence and clothing. This new evidence was compared to hair DNA taken from Manuel Bracamontes, the early suspect in 1991. The comparison revealed that the suspect's DNA matched the biological material originally taken from the young victim.

A retired detective, Bob Conrad, was assigned to the case as the lead detective. The San Diego District Attorney's Office requested that the author assist the Chula Vista Police Department in the ensuing investigation. The author was shown photographs of the autopsy, which revealed through and through penetration of the mandible and a scapula. The actual mandible and scapula were also examined. The suspect, a municipal bus driver was arrested and charged with special circumstances in connection with the homicide. The death penalty was sought by the San Diego District Attorney's Office.

The author visited the crime scene with criminalists and investigators to collect evidence of the indentations in the sidewalk. Debris was removed from the depressions and impressions of these areas were completed employing Exafast NDS impression material. These "plugs" were removed upon setting and were observed to be of a triangular pattern. Detective Conrad had suggested that the murder weapon might have been a small pickaxe known as a pick-mattock. Court exhibits were constructed displaying the relationship of the weapon to the injuries discovered in the scapula and mandible. The author testified as to the relationship of the weapon and the scapula and mandible injuries, fractures seen on the mandibular and maxillary incisors as well as the sidewalk indentations. This presentation will present a step-by-step demonstration of the principles in this case.

The suspect was found guilty by a jury and was subsequently sentenced to the death penalty on December 14, 2005, over 14 years after she died.

Pickaxe, Body Perforations, Sidewalk Perforations

F37 Traffic Stop Leads to the Discovery of Three Bodies

Norman D. Sperber, DDS, 3737 Moraga Avenue, #A-302, San Diego, CA 92117-5457*

After attending this presentation, attendees will know how forensic dentists may often assist investigators in complex cases.

This presentation will impact the forensic community and/or humanity by demonstrating how forensic dentists may assist in cases other than identifications, bite marks, and age determination.

While in a pursuit of a Hummer, on September 15, 2003, San Diego County Deputy Sheriffs made a chilling discovery when the vehicle finally stopped. It had almost overturned in a canyon in Ramona, California, a mountainous area just northeast of the city of San Diego. The deputies were chasing this particular vehicle because reportedly it had been involved in a hit and run accident earlier that morning. As the officers approached the tilting Hummer, they observed a male exit from the driver's seat at 0517 hours. Mark Jensen, who was operating the vehicle, crawled out of the driver's side window and tried to flee the area. Deputies kept their distance because the suspect was armed with a weapon. He fell down a small embankment and took refuge. Deputies kept yelling at him to drop his weapon, but he refused. He told deputies that he had two people in the Hummer and they should "check on them." He also stated that he wanted to commit suicide and "wanted to see his last sunrise." A SWAT team was dispatched to the scene due to the standoff. After a lengthy interval, this suspect shot himself in the head at 0700 hours. SWAT members secured the weapon. When they broke out the right rear window of the vehicle, they found two bodies inside. Also inside, but very much alive, was the girlfriend of the individual who shot himself just minutes previously.

Apparently, the four individuals had been at a party at the home of the individual who owned the new Hummer when the female survivor became exceedingly intoxicated and asked to be driven home. All four were in the vehicle when the male who committed suicide shot the car owner and his girlfriend. As the resulting investigation unfolded, detectives discovered that the individual who shot the victims was a parolee and had been released from prison one week before the murder-suicide. The victims were believed to be the third or fourth persons killed by this same individual during his lifetime. The female survivor told investigators that she really did not know what had occurred because she had "faded in and out of consciousness during the ordeal." At the postmortem examination, it was obvious that the female victim had suffered a penetrating gunshot wound of the left side of the face.

At autopsy, a linear defect in the right side of the face of the female victim was noted and an ovoid defect in the left side of the face. The lead detective contacted the author in an effort to determine the cause of the cheek indentation listed above. The survivor female was known to carry a straight razor. A blood stained straight razor was found in the Hummer. A straight razor consists of a blade, which retracts into the handle. At the end of the blade there is a rounded portion called the "tang." The tang is restrained by the fingers during a shaving procedure so that the blade does not fold into the handle. On 11-19-03 at 08:05 hours, the author examined images of the right cheek indentations found below the zygomatic arch and posterior to the corner of her lip. This horizontal lesion was caused by a small rigid object and appeared to have been delivered in an anterior to posterior direction.

It was the author's opinion that this right face wound was consistent with the feature of the tang described above. Although the horizontal

margins of the wound appear to be 3mm apart, whereas the tang's width was slightly more than 2mm, this slight discrepancy was explained by the fact that tissue tends to separate when the epithelium and connective tissue are penetrated. Therefore, it is certainly possible that the tang portion of the razor in this case caused the described injury.

Subsequently, the female suspect plead guilty and received a sentence of 12 years in prison.

Straight Razor, Tang, Homicide-Suicide

F38 Aesthetic Ranking of Denture Identification Methods

Raymond Richmond, MPhil, and Iain A. Pretty, DDS, PhD, The University of Manchester, Dental Health Unit, 3A Skelton House, Manchester Science Park, Lloyd Street North, Manchester, M15 6SH, United Kingdom*

After attending this presentation, attendees will be familiar with: a) a selection of the various methods that have been used over the years to mark dentures; b) the results of a patient survey designed to determine the most suitable method of denture marking in terms of the patient's perception of aesthetics.

This presentation will impact the forensic community and/or humanity by demonstrating how it is essential that the dental community consider introducing mandatory denture marking. The role of forensic dentists in bringing about this change through advocacy and education is highlighted within this presentation.

Introduction: Following major disasters such as earthquakes, fires, or floods, a definitive and early identification of the dead and injured becomes of the utmost importance. Often this identification must be accomplished via the use of odontological methods. Determination of the various individual physical and genetic characteristics of the human dentition has proved to be very efficient in aiding the task of identification. Edentulous subjects, on the other hand, have lost all or most of the key features that have proven valuable in such cases. Hence, the process of identification is made much more difficult unless the victims wear identification (ID) marked dentures.

Study: A survey of 100 Manchester Dental Hospital denture patients receiving complete and/or partial dentures was undertaken in order to determine both their attitudes toward denture marking, and also their preference for the type of marking in terms of aesthetic value. Patients were shown ten, 12 x 4 inch color photographs labelled (a) to (j) comprising each of the following denture ID marks:

Label (a). showing a technique in which the patient's name was typed on a piece of 'onion skin' paper and incorporated within the fitting surface of the denture during the packing procedure.

Label (b). showing a method involving the use of a typed, commercially produced metal strip (trade name: ID-Band) embedded into the polished surface of the denture.

Label (c). showing a RFID system consisting of a data carrier, generally known as a tag or transponder, The tag consists of a torpedo shaped microchip with a coiled antenna measuring 8.5mm x 2.2mm. The transponder was embedded into the fitting surface of the already fabricated denture.

Label (d). showing an example in which a fine fiber-tipped pen was used to mark a label made from a partially polymerized strip of PMMA before including in the fitting surface of the denture base during the trial packing procedure.

Label (e). shows an example of an ID label that had been produced in a 'P - touch' electronic lettering system (P - touch, Brother Co, Canada). The label used consisted of a 103µ thick, white or clear laminated strip onto which 2mm characters are typed, after which it is incorporated into the denture subsequent to its fabrication.

Label (f). utilizing a standard soft metal band that is either typed or engraved with the patient's details before being rolled up and inserted into

a predrilled cavity approximately 2-3mm wide. A small wax plug is then placed over the metal band prior to filling the remainder of the cavity with self-cure resin.

Label (g). is made from a label printed on 35mm photographic slides via the use of a computer graphics package.

Label (h). utilizing piece of 0.125mm thick stainless steel tape onto which the patient's details are engraved. The tape is then incorporated into the fitting surface of the denture during the trial packing stage.

Label (i). showing an example that involves cutting a groove of approximately 0.5 to 1mm deep into the buccal flange of the denture; the length of which would correspond to the length of the patient's name. An ordinary ballpoint pen or felt-tip pen is then used to print the patient's name in the recess before being sealed with fissure sealant

Label (j). showing an example that allows the dentist to write on the surface of the denture using a spirit based pen or pencil prior to covering the ID mark with a clear denture base polymer dissolved in chloroform.

Ethical approval for the study was obtained and each patient signed an informed consent form. Data were entered into SPSS and the mean aesthetic rank for each denture identification method was produced.

Results & Conclusion: Denture mark labeled 'C' (incorporating the transponder) was a clear favorite, preferred in 49 of the one hundred patients. The second favorite was denture 'A', (incorporating the onion skin paper within its fitting surface). However, this was only ranked 1 by 13 people. Denture 'I' was the most disliked ID mark; only two patients ranking it in first place. When asked whether they would prefer some form of ID mark incorporated into their denture in the future, all but one patient gave a positive response. With the prevalence of mass disasters and the increasing threat of global terrorism, it appears self-evident that the incorporation of some form of ID marking of dental prostheses should be made mandatory.

Identification, Denture, Survey

F39 A Pilot Study to Investigate Sexual Dimorphism of the Teeth in a Guatemalan Forensic Population

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After attending this presentation, attendees will have gained an insight into a practicing forensic investigations and see how population-specific research can be immediately implemented into modern case reports that are presented to the judicial system in Guatemala.

This presentation will impact the forensic community and/or humanity by providing an additional tool in sexing the skeleton for the forensic community currently working in Guatemala in exhumations relating to the massacres that took place in the early 1980s. It is especially applicable to remains in a poor state of preservation and can be incorporated into forensic reports presented to the courts in Guatemala. It can also be used with caution for other populations within the Americas and for prehistoric Mayan populations. It can encourage other population-specific investigations relating to identification in forensic investigation in the human rights field.

The Guatemalan Forensic Anthropology Foundation (FAFG) currently works on the exhumation and analysis of victims of the Guatemalan Civil War mainly from the early eighties.

The majority of the remains are fully skeletonized with taphonomy such as climate (temperature and humidity), soil type, scavenging, insect activity, and human intervention influencing preservation of the remains. As a consequence, many skeletons recovered are incomplete and, in some cases, highly fragmentary making sex difficult to ascertain using traditional pelvis, skull and metric sexing techniques. Therefore, it is essential that methods be developed at the population-specific level to determine sex using the skeletal elements that are recovered, which is

often the dentition. The purpose of this pilot study is to aid in the determination of sex based on the sexual dimorphism of teeth of the Guatemalan indigenous Mayan population.

The Guatemala massacres indiscriminately included men and women, young and old, which further complicates the process of identification. In poorly preserved cases, the clothes are used to determine sex. In court, this type of inference falls under a “presumptive identification,” and in Guatemala it is the ultimate decision of the judge to make a positive identification proving that scientific methods for sexing these skeletons is imperative. In addition, there are poorly preserved cases where the victims were buried without clothes, again suggesting the need for scientific methods. Therefore, the research from this pilot study is invaluable to the work of the FAFG.

Research on the determination of sex from teeth has been published with encouraging results and high confidence levels. There is general consensus that canines are the most sexually dimorphic teeth (Hillson 2005), while incisors, premolars, and the first molars are also useful for determining sex (Ditch and Rose 1972). In this pilot study, the first step is to determine if the teeth are sexually dimorphic within this population by testing the measurements set out by Ditch and Rose (1972). If this is validated, the next step is to incorporate the most sexually dimorphic teeth into a discriminate function analyses by following the statistical techniques of Ditch and Rose (1972). The advantage of this method is that it can be used to sex juveniles once the tooth crown has formed even if it has not erupted fully. The data set consists of 100 (fifty male, fifty female) adult Guatemalan Mayan skeletons of known sex.

The discriminate function analysis from this pilot study provides a scientific and population specific method that can be used alongside more traditional metric and non-metric sexing techniques in the FAFG. The results and implications of this research as related to population variation in morphology and the scientific analysis of cases will be discussed in this presentation.

Guatemalan, Sexual Dimorphism, Teeth

F40 Morphometric Analysis of the Root Development of the Third Molar by an Experimental Method Using Digital Orthopantomographs

Francesco Introna, PhD, MD, Valeria Santoro, DDS, Piercarlo Lozito, DDS, and Antonio De Donno, MD, Section of Legal Medicine, University of Bari, P.ZZA Giulio Cesare N.11, Bari, 70124, Italy; and Gaetano Marrone, DSc, Section of Statistical and Economics Science, University of Pavia, Strada Nuova N.65, Pavia, 27100, Italy*

After attending this presentation, attendees will understand a study designed to investigate the accuracy and precision of the development of the third mandibular molar, determined on digital panoramic X-Ray, by a morphometric analysis as an indicator of chronological age in a sample of 330 16-19 year-old subjects

This presentation will impact the forensic community and/or humanity by demonstrating a new, very interesting method in personal identification.

Introduction: Determination of adult age by the analysis of teeth is frequently an important forensic issue because it may determine whether an individual convicted of a crime is sentenced as an adult and incarcerated in a state penal institution or sentenced as a juvenile and sent to a juvenile camp.

The aim of this study was to test the possibilities of use of digital OPT on the basis of morphometric analysis of the development of the third molar.

The research that was carried out on digital OPT was based on the criteria of identification by morphometric analysis with the purpose of exceeding the limits of an exclusive morphological analysis. In fact, it

revealed that morphological analysis presents difficulty in the precise placement of the third molar in the various stages of development.

The risk is therefore one of having a difference in the results obtained from various examiners caused by the subjectivity of the criteria of evaluation adopted from each individual; this kind of analysis indicates the length of the roots, which is a part of the final length neither known nor predictable.

There is therefore a need for conducting a morphometric analysis in the area of looking for a constant dimensional crown-root ratio (C/R) with a standard deviation that consents objective analysis of the example.

The study’s goal was therefore of predicting a final root length, having noted the crown dimension, and finally obtaining a ratio between the effective root length in the third growing molars, and that which is finally foreseen.

Materials and Methods: In the application of this method, measurements were taken only on mandibular molars. From the beginning, two points of the cemento-enamel junction (AC) were identified for tracing the straight line that joins those points. Subsequently, parallels to the straight line were created tangent respectively the summit of the highest coronal cusp and the apex of the longest root (or the most apical part of the calcified root in the development phases).

The measurements were done on the perpendicular conducted for the three straight lines between their parallel with the objective of reducing to a minimum the error in the calculating phase. Both passages (design drawing of the line and the measurement), as well as the acquisition of the OPT were accomplished by digital systematic research using a specific dental software.

In the first phase of this study, the existence of a constant ratio C/R was verified on a sample of 100 third molars characterized by a complete root development.

Statistic analysis was conducted targeted at individualizing the arithmetic mean of the ratios with a standard deviation that produced an average value of the C/R ratio equal to 0.518 and a standard deviation of 0.05.

This outcome is supported by results from an inferential study that has permitted researchers to determine, with assurance equal to 95%, an interval (interval of confidence) inclusive between 0.509 and 0.528, with internally inserted the relationship C/R of the population of reference (Italian) from which the sample was taken.

In the second phase of the study, a sample of 330 third molars with developing roots that belonged to the age from and including 16 to 19 years old are analyzed and divided according to sex.

The value obtained from the first phase of the study was used in the successive phase, formulating that in the third molars with developing roots, the measurements of the length roots total (It), knowing the crown height (h): $It = h / (C/R \text{ mean})$

Lastly, knowing the total length of the roots the ratio between the length of the developing roots and those finally foreseen are calculated.

The second statistic analysis was based on the calculation of the standard deviation and the interval of confidence where internally was present the ratio between partial roots and total (Rp/Rt) for every class of age. It allowed the attribution at each class of age, whether it is male or female, a different numeric value and therefore being able to estimate the age with a precision equivalent to 95%. The results are shown below:

GROUPS	Ratios Rp/Rt(means)	Dev. Standard	Confidence Interval (95%)
Males 16	0.43364	0.1458615	(0.3734313 ; 0.4938487)
Females 16	0.43979	0.2287706	(0.3760983 ; 0.5034786)
Males 17	0.66239	0.1517706	(0.6217484 ; 0.7030373)
Females 17	0.58784	0.2297738	(0.5263055 ; 0.6493731)
Males 18	0.73549	0.1759996	(0.6750277 ; 0.7959437)
Females 18	0.71721	0.1670609	(0.6651544 ; 0.7692741)
Males 19	0.84992	0.2766183	(0.7357376 ; 0.9641024)
Females 19	0.81152	0.2030861	(0.7342674 ; 0.8887671)

Age Identification, Third Molar, Forensic Odontology

F41 Age Estimation From Progressive Changes in Dental Pulp Chambers

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The goal of this presentation is to add data to the postulate that examination of secondary pulp formation can be done radiographically and thus be applicable as a noninvasive indicator for both the living and deceased in adult human age estimation.

This presentation will impact the forensic community and/or humanity by demonstrating a noninvasive examination of teeth using radiographs in both living and deceased individuals as a means of age estimation.

Several methods of age estimation are available to forensic scientists and it is beneficial when multiple modalities can be used to further narrow ranges or reinforce conclusions. Some established methodologies are limited to postmortem examination. Some methods of age estimation, e.g., radiographs of epiphyseal development, pubic topography, suture line closure, lipping of vertebrae, etc., may be compromised or impossible to apply if remains are fragmentary. Teeth often survive extremes of time and trauma. Studies have shown that the size of the dental pulp chamber is reduced with advancing age as a result of secondary dentin deposition by the pulp. In this effort to evaluate a correlation between pulp chamber size and an individual's age, the premise investigated within this study suggests a noninvasive examination of teeth using radiographs in both living and deceased individuals as a means of age estimation.

This study reexamines work presented by Kvaal, et al, and adds data to the postulate that the examination of secondary pulp formation can be done radiographically and is thus, applicable as a noninvasive indicator for both the living and deceased in adult human age estimation. The design of this study parallels the technique and parameters described in Kvaal's paper in *Forensic Science International*, Vol. 74, Issue 3, 28 July 1995,

Pages 175-185. This study is an effort to further validate or challenge the earlier reported findings. The study material for the current project was date-labeled periapical radiographs of 100 patients of known age from one author's private dental practice. Full mouth radiographic images were photographed on a standard view box with a Fuji Pro S2 digital camera, tripod, and remote shutter cable switch. Adobe Photoshop CS software features were used for enhancement, magnification and measurements. The selected radiographs were of the six types of teeth selected in the Kvaal study: maxillary central and lateral incisors and second premolars, and mandibular lateral incisors, canines and first premolars. Subjects with a history of missing target teeth were excluded from this study and individuals with restorations in the target teeth were also excluded from this study to avoid the introduction of reparative dentin variables skewing the results. The evaluation of several teeth from the same individual also contributed data regarding whether specific teeth have a stronger association between secondary dentin formation and age. Several ratios of defined pulp dimensions (established in the earlier study) to overall tooth morphology were calculated for the defined target teeth. Ratios were used rather than direct measurements to reduce the impact of variation in magnification and angulations of the radiographs. Statistical analyses were used to validate or discount the significance of Pearson's correlation coefficient between age and the different ratios for each type of tooth. Principle component analyses were performed on all ratios. Regression analyses were also calculated. The calculated values were studied for strength, weakness, or statistical relevance/significance to the age of the individual.

The coefficient of determination was strongest when all ratios from the six teeth were included in the mean and weakest when only the mean values of the ratios from one tooth were included. As stated earlier, obtaining more extensive information for each individual results in age estimation with a narrower range. These findings support previous studies that show the advantage of pulp/tooth ratio analysis over root/tooth ratio analysis as an age estimation method.

Additional data should be developed through studying a larger volume of subjects. Studies are also needed on specific populations.

Age Estimation, Forensic Odontology, Dental Pulp Chamber



G1 Sudden Unexpected Death in a Case of Human Immunodeficiency Virus (HIV) and Mycobacterium Infection Diagnosed Postmortem

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After attending this presentation, attendees will learn: 1) Initial diagnosis of HIV/AIDS can be made postmortem by performing thorough histological examination and necessary laboratory tests, 2) Sudden death can occur in cases of unsuspected HIV/AIDS cases with non-tuberculous Mycobacterium infection in spleen and lymph nodes, 3) PCR technique is available for identifying Mycobacterium species in formalin-fixed paraffin-embedded tissues.

This presentation will impact the forensic community and/or humanity by assisting the forensic pathologists in better identifying HIV/AIDS cases at an early stage, so that it will benefit the immediate family and the community.

This 35-year-old female was found unresponsive at her residence at 6:00 pm. She was pronounced dead at emergency room after the usual resuscitative measures. She had a full-day work as a clerk stenographer and left work at 4:00 pm. She stated to her co-worker that she had chills while riding down on the elevator to leave work. She had a history of cervical carcinoma-in-situ that was treated with total hysterectomy and recently had laser vaporization for dysplasia of vaginal wall. She had been otherwise in good health. At autopsy the spleen was slightly enlarged and had gray nodules and there were skin ulcers in perineum. Microscopic examination of the spleen revealed ill-defined epithelioid cell granulomas containing rare acid-fast bacilli (AFB). Sections of mesenteric lymph nodes revealed lymphoid depletion and numerous AFB in ill-defined epithelioid cell granulomas. The skin ulcers were microscopically consistent with herpes simplex virus infection. In view of the presence of cervical carcinoma-situ, vaginal wall dysplasia, Mycobacterium infection, and herpes simplex skin infection, HIV-1 antibody tests (enzyme-linked immunosorbent assay and Western blot assay) were performed on a blood specimen taken at autopsy. Both tests were positive. Further investigation revealed that the decedent's brother had known that the decedent might have had HIV infection, because her ex-boyfriend had told him that she might have been infected with HIV. To identify Mycobacterium species the formalin-fixed paraffin-embedded tissues of mesenteric lymph nodes were sent to Central Arkansas VA Medical Center laboratory, where Mycobacterium tuberculosis DNA complex was not detected by use of polymerase chain reaction (PCR) assays. This case was reported as HIV/AIDS to NJ State since the diagnosis had not been made antemortem.

HIV/AIDS, Sudden Death, Mycobacterium

G2 Assisted Suicide as Practiced in the French Part of Switzerland

Sandra E. Burkhardt, MD, Jerome Sobel, MD, and Romano La Harpe, MD, Institute of Forensic Medicine, 9, Avenue de Champel, Geneva, 1206, Switzerland*

After attending this presentation, attendees will understand the legal aspects of assisted suicide in Switzerland, where the penal code condones this practice for altruistic reasons, even if not performed by a doctor; the prevalence of this type of death and the way it is treated.

This presentation will impact the forensic community and/or humanity by demonstrating how the number of cases of assisted suicide is growing every year in Switzerland, responding to the requests of very sick patients, when palliative care and other alternatives are not efficient enough anymore.

Assisted suicide is permitted in several countries and jurisdictions: Belgium, the Netherlands, the state of Oregon (USA) and Switzerland. The practice of assisted suicide is controversial leading to debates among doctors, jurists, and ethicists.

In Switzerland, article 115 of the Swiss penal code considers assistance suicide a crime if and only if the motive is for personal gain. It condones assisting suicide for altruistic reasons. This allows associations such as EXIT-ADMD (French Switzerland), EXIT German Switzerland, or DIGNITAS to assist severely ill patients under certain conditions in their desire to end their lives.

This study takes into consideration 200 cases of assisted suicide performed by the association EXIT-ADMD between 2001 and 2005. The districts of Vaud and Geneva were the primary focus of this study, with and the number of cases increasing continually over this time period. Most of the patients were female. The most frequent pathologic conditions were neoplasia, neurological diseases, and cardio-vascular diseases. The average age of patients was over 70. More than ¾ of assisted suicides occurred at home; 20 patients died at a nursing home. Due to internal policy restrictions, some of the patients had to leave the hospital or nursing home in which they were staying in order to receive assistance with their suicide.

The most common lethal substance used by patients, when assisted in their suicide, was sodium pentobarbital (between 11 and 15 grams) inducing coma within less than ten minutes, and leading to a painless death within than 30 minutes. At the moment of death, their family or relatives surrounded most patients.

Legal requirements following such a death are quite simple in Geneva. As it is a violent death, the forensic physician must examine the remains, and completes a death certificate noting the unnatural nature of death. Based on these medicolegal observations, the police officer completes a document called the "Nihil Obstat." This permits burial of the remains to take place without any other formality, allowing for full respect of the deceased and his/her family.

Assisted Suicide, EXIT Association, Switzerland

G3 Firearms Injuries: Beyond Entry and Exit Wounds

Rosa Falamingo, MD, PhD, and Francesco Vinci, MD, Section of Legal Medicine (Di.M.I.M.P.) - University of Bari, Piazza Giulio Cesare, Policlinico, Bari, 70124, Italy; and Carlo P. Campobasso, MD, PhD, Department of Health Sciences (Di.S.pe.S), University of Molise, via De Sanctis, snc, Campobasso, 86100, Italy*

After attending this presentation, attendees will learn (1) the diagnostic features of pattern injuries made by firearms; and (2) their relevant role in criminal investigations.

This presentation will impact the forensic community and/or humanity by showing several case studies in which patterned abrasions and wounds were useful in the identification of the firearms used and in the reconstruction of the assaults.

Patterned injuries usually occur when the force is applied at or near a right angle to the skin surface, rather than with the skidding impact of a graze. If a weapon with a patterned surface strikes the skin, abrasions or bruises and even lacerations follow the ridges of the object if it has a

profile of varying height. Formerly it was often claimed that abrasions retained the pattern of the impacting object more accurately than other injuries such as bruises and lacerations. However, even if abrasions do preserve such patterns well, bruises and lacerations may also follow the profile of the inflicting object reproducing exactly the imprint of firearm weapons and/or its parts.

The plastic grip of a firearm weapon can easily imprint its design on the skin producing bruises and/or lacerations at the edges of the impact site such as heavy objects with firm impacts use to do. The skin between the thumb and index finger of the hand holding a pistol may slightly overlap the lumen of the barrel so that a graze wound can occur. Shape and size of pattern injuries are often useful for the identification of the weapon used in the assault. In the literature, there have been many reported cases in which additional pattern injuries have been found in the area surrounding the entry wounds produced by shotguns, revolvers, and semiautomatic pistols due to the peculiar firearm muzzle design. These findings have been used in shooting reconstruction and also to establish the range of fire. It is well known that if the discharge is contact, the muzzle of a firearm can imprint an abrasion on the skin surface. Hard and loose-contact wounds have been described depending on whether the muzzle of the weapon is jammed "hard" against the skin (so that the skin envelops the muzzle) or held lightly against the skin. Even when there is a gap between the muzzle and the skin, for example when the barrel of the weapon is held at an acute angle to the skin, the muzzle can imprint part of its circumference thus producing angled or incomplete-contact wounds. Difficulties in interpreting such pattern injuries may occur when the injury involves a surface not completely flat such as the head. In these cases the position of the edge that digs in most deeply may give an indication of the angle of the blow.

Pattern Injuries, Firearm Wounds, Ballistic

G4 The Mummified Corpse Found in a Domestic Setting

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After attending this presentation, attendees will gain an understanding of the forensic and ethical issues pertaining to unattended deaths of those with little or no contact with society and the mummified remains found after a significant period of time after death.

This presentation will impact the forensic community and/or humanity by presenting a case of a mummified corpse found several years after death.

Mummification refers to all natural and artificial processes that bring about preservation of the body or its parts. Such processes include primarily the drying of the soft tissues instead of liquefying putrefaction. The essential requirement for mummification is a dry environment, preferably with a moving air current, which is usually in a warm environment. The most widely known form of mummification is in hot and arid areas like Egypt, Chile, and Peru. It is also likely to occur in temperate climates especially when the body is left undisturbed in warm dry place such as closed rooms, closets, and attics.

A mummified body of an 86-year-old white male with a history of coronary atherosclerosis was found in the entryway of his apartment located in a condominium of the city of Bari (Southern Italy) approximately seven years after death. The body was sitting on the carpet in front of an easy chair, clothed in a woolen vest with dark pants and shoes. The head was lying face down on the easy chair and the scalp with long grey hair was still present. The appearances of mummification

included desiccation and brittleness of the skin, which was stretched tightly across anatomical prominences such as the cheekbones, chin, costal margin, and hips. The skin and the underlying tissues of the body were darkened, hard, forming a leathery shell over the body and making autopsy dissection difficult. The corpse was well preserved through the mummification process and no external injuries were observed. There was little evidence of insect activity. The shutters of the entry way were closed but the windows were open so that there was accessibility to air. The carpet on which the body was sitting and the upholstery of the easy chair on which the head was lying absorbed most of the early putrefactive fluids. Several empty pupae of *Lucilia sericata* and *Calliphora vicina*, cast larval skins of Dermestidae (Coleoptera) along with dermestid frass (excreta) were found on the floor close to the body suggesting a death occurred during the spring season.

Mummification often occurs in elderly bodies due to rapid dehydration of the outer surface. The rapidity of dehydration may reduce the usual swelling of the body preventing also putrefaction by enteric microorganisms, soil bacteria, and other decay organisms. The rapid drying of soft tissues may also protect the internal organs even from insect colonization as in this case where after the drying had taken place, the corpse remained in that state for many years with no insect activity at all. Larval infestation for all blow fly species is usually hindered by the rapid dehydration of the skin surface; female adults recognize dehydrated and/or mummified skin as inhospitable to the larval stages which need both moisture and accessibility to air. Radiographs of the body disclosed osteoporosis but no fractures or other evidence of blunt trauma. The internal organs were well preserved. However, the cause of death was undetermined. Based on the antemortem data available the remains were rapidly identified by dental comparison. The man had been missing seven years. The neighbors stated they had thought that the man had died a long time ago. Unpaid electricity bills resulted in termination of electrical service. The paid condominium bills forced the manager of the condominium led to the entry of the apartment.

Mummification, Postmortem Changes, Forensic Taphonomy and Entomology

G5 Acute Hemorrhagic Leukoencephalopathy (Weston-Hurst Disease): A Natural Disease Presents as Head Trauma

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The goal of this presentation is to describe a case of death due to acute hemorrhagic leukoencephalopathy (AHL), a natural disease masquerading as head trauma.

This presentation will impact the forensic community and/or humanity by demonstrating how AHL, a natural occurring brain disease which may mimic brain trauma and must be considered in the differential diagnosis of cerebral hemorrhage.

Naturally occurring neurologic disease may occasionally mimic traumatic injury.

A 19-year-old man complained of headache after bouncing a soccer ball on his head. He was admitted to a hospital where he became lethargic, then comatose. A computed tomographic (CT) scan revealed dense, bilateral, frontal lobe hematomas. Angiography did not demonstrate vascular abnormalities. A craniotomy was performed to evacuate the hematomas; however the patient died after a four day hospitalization. Further history revealed that the patient may have sustained head trauma during an altercation in the days previous to the hospital admission. Because of the possibility of a trauma related death, jurisdiction was assumed by the medical examiner and an autopsy was performed. Gross

neuropathologic examination revealed a swollen, soft brain that exhibited evidence of surgical intervention and transtentorial herniation. The frontal lobes had dense, confluent hemorrhages, located predominantly in the white matter, extending across the genu of the corpus callosum. Additional foci of hemorrhage were in the convolutional white matter of the cingulate gyrus and the internal and external capsules. There were no cortical contusions or other traumatic pathology. Histologic examination demonstrated perivascular hemorrhage surrounding necrotic blood vessels with fibrinous exudates within the Virchow Robin spaces, perivascular inflammation, and demyelination. These findings were diagnostic of AHL.

AHL, or Weston-Hurst disease, is a rare inflammatory, demyelinating disease of the brain characterized clinically by an abrupt onset of neurologic symptoms and signs with rapid progression. Its onset is frequently associated with an antecedent viral illness. The disease is usually fatal, although recovery has been described with medical treatment. The clinical differential diagnosis includes herpes simplex virus type 1 encephalitis, meningoencephalitis, encephalomyelitis, sagittal sinus thrombosis, central nervous system vasculitis, and in the elderly, congophilic angiopathy. Traumatic injuries are usually not entertained in the differential diagnosis, although the gross findings are similar to those associated with fat embolism following skeletal fractures. In this case, the unusual CT scan findings and the history of possible antecedent head injuries led to the suspicion that the lesions resulted from head trauma. This case illustrates the importance for forensic pathologists to recognize AHL as a natural disease process that may rarely mimic traumatic brain injury.

Head Trauma, Acute Hemorrhagic Leukoencephalopathy, Demyelinating Disease

G6 Weight That Kills: Adults With Natural Deaths are Heavier Than Those Dying Non-Naturally — A Cross-Sectional Study

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After attending this presentation, attendees will understand the impact of obesity on natural death by applying standard epidemiologic techniques to data obtained at the State of Maryland Medical Examiner Office.

This presentation will impact the forensic community and/or humanity by highlighting the problem of obesity and raising awareness of how deep and broad the problem is and the need to address it.

Introduction: The morbidity and mortality produced by obesity in the United States and other developed societies has reached epidemic proportions. Although the problem starts in childhood and adolescence, the medical impact takes hold in adult life. Clinical studies have shown the effect of obesity on cardiovascular disease, diabetes, cancer degenerative joint diseases among others, and some autopsy studies have confirmed the clinical findings.

Aim: To evaluate the magnitude and severity of the impact of obesity on mortality

Hypothesis: Excess weight is a risk factor for mortality; thus Body Mass Index (BMI) in individuals with a natural death is higher than in those with non-natural deaths (they would be alive if not for the non-natural factors).

Methods: Cross-sectional study involving young and middle age adults (ages 20 – 50 years) in the state of Maryland whose death during a recent three year period (2002-2005) was either unexpected or violent.

Cases were selected from the State of Maryland Office of the Chief Medical Examiner (OCME) database. The State of Maryland has a single,

centralized office that covers the entire state. All non-natural deaths and purely natural deaths that are unexpected or unsupervised by a physician, affecting persons under 50 years of age are transported to the office for cause of death investigation.

- Each body was measured and weighed upon arrival at the OCME.
- BMI was calculated following a standard formula (BMI = weight in kilograms/squared height in meters)
- Cases were tabulated by age, gender, manner of death, height, weight, BMI and BMI NIH categories (normal [BMI <25], overweight [25≤BMI<30], obese [30≤BMI<40] and very obese [BMI≤40])
- Non-natural deaths (Accident, Suicide, Homicide and Undetermined) were analyzed separately and grouped together for comparison
- Statistical analysis included descriptive statistics and multivariate logistic regression, using likelihood ratio tests of statistical significance. Effect sizes were estimated by odds ratios (OR)
- Possible bias (systematic errors impacting the different groups differently) were sought and discussed

Results: The study included 6987 individuals, 2097 (30.0%) had natural deaths and 4890 had non-natural [1345 (19.3%) were accidents, 1210 (17.3%) were homicides, 642 (9.2%) were suicides and 1693 (24.2%) undetermined.

- The percentage of women in the natural death group was higher (34.0%) than in the non-natural deaths (21.5%), and the average age (SD) was higher for the group of natural deaths (41.3 +/-7.0) than the group of non-natural deaths (35.1 +/- 9.0).
- BMI was an independent risk factor (p<0.0001, OR=9.4) for natural death when adjusted for age (p<0.0001, OR=15.4) and gender (p<0.0001, OR=1.7 F/M) in a multivariate logistic regression analysis. Per unit of measure, BMI was a comparable risk factor to age.
- The mean (SD) BMI in natural deaths was higher than that of non-natural deaths: 29.3 (9.1) vs. 27.5 (6.5).
- The percent of natural deaths among the different BMI levels was 26.9% for people in the normal weight range, 27.9% in the overweight group, 32.1% in the obese group, and 48.6% among the very obese.

Conclusions: In an adult population, the relative frequency of natural death increases steadily with increasing levels of obesity. This increase persists when adjusted for both age and gender, indicating that obesity is an independent risk factor, comparable or greater in its effect to age.

Obesity, Body Mass Index, Natural Deaths

G7 Forensic Science “Case Derived” Templates Formulated With Relational Database Software

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This presentation demonstrates the forensic science utility of commercial open-marketed relational databases in template and table production, report and forms formulations, and query fashioning.

This presentation will impact the forensic community and/or humanity by demonstrating the valuable and available merits of relational database use in the forensic sciences as a readily learned, available, and important tool in the armamentarium of the forensic scientist.

Using Microsoft Access relational database software, a series of templates are presented covering forensic science topics, especially those arising in forensic pathology and crime laboratory environment.

Templates are important graphic aids in data entry and case analysis; in relational databases they are formulated by critically selecting fields for data tables. Precise and accurate derivations of essential factors pertaining to the selected data item are necessary; however, database structures are readily edited, improve with review, making templates dynamic and progressive. The ease of template production is emphasized.

Other dimensions of relational database software are demonstrated and include the production of relational tables, the use of queries, and the production of forms and reports. Relational database application mastery is presented as a legitimate forensic science skill.

Evaluations of the available relational databases on the basis of ease of use, availability of support services and educational courses, certifications, personal application, and cost are presented. A summative reference is made available.

Relational Database, Templates, Computer Software

G8 Three Unusual Neuropathologic-Related Causes of Sudden Death

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The goal of this presentation is to make the audience familiar with three unusual neuropathologic entities that may contribute to sudden death in the medicolegal setting.

This presentation will impact the forensic community and/or humanity by demonstrating cases that exemplify the range of neuropathologic maladies that may contribute to sudden, unexpected or suspicious deaths highlight the asset a neuropathology consultation provides and emphasize the utility of postmortem examinations in the elucidation of medical diseases and co-morbidity.

The autopsy findings of three medicolegal cases of sudden death associated with uncommon neuropathologic findings of which the general forensic pathologist may not be familiar are reviewed. Two cases were unexpected deaths that involved relatively young patients with histories of seizure disorders. Neurologic disorders were suspected but the exact relationship to the cause of death was not defined until postmortem examination. The other patient was elderly, thus, not an unexpected death; however, because of circumstances surrounding the scene investigation an autopsy was performed and an unexpected rare neuropathologic abnormality was found.

Case 1 was a 43-year-old male with a history of congenital nevi of his head, torso, and extremities. The patient also suffered from hypertension, chronic alcoholism, and a poorly controlled grand mal seizure disorder of five years duration prior to death. He was discovered unresponsive in a bathroom and autopsy revealed a malignant melanocytic tumor diffusely infiltrating the leptomeninges and focally the cortex of the superior gyrus of his left temporal lobe. The cause of death was attributed to a seizure due to a malignant melanoma of the temporal lobe arising in the context of neurocutaneous melanosis.

Case 2 was a 57-year-old female with a history of mental retardation, clumsiness, incoordination, and a childhood seizure disorder that developed as a sequel to chronic infantile lead poisoning. She was discovered unresponsive and asystolic on her bedroom floor. Twelve days prior to her death she had a witnessed fall down a staircase, and fractured her left leg. The cause of death was a pulmonary thromboembolism due to deep venous thrombosis status post left leg fracture. Autopsy also revealed profound atrophy and gliosis of her cerebellum consistent with residual damage from chronic lead poisoning. Although peripheral nervous system involvement in chronic lead poisoning is well known, less so is marked cerebellar atrophy with subsequent incoordination as occurred in this case.

Case 3 was a 75-year-old female with a history of chronic osteoarthritis, hypertensive atherosclerotic cardiovascular disease, and

depression and, six month duration of neck and head pain. She was found dead in bed under suspicious circumstances so a postmortem examination was performed. The cause of death was due to acute bacterial lept meningitis at the cervico-medullary junction, acute inflammation of the adjacent dura mater and the tissue of her upper cervical spinal column associated with subluxation and instability of her atlanto axial (AA) joint. The case compares to what is known as Grisel's syndrome, a subluxation of the AA joint due to inflammation-induced ligamentous instability associated with an infectious/inflammatory process of the head or neck. Grisel's syndrome is more often found in children than adults; it may produce spinal and neurologic complications and, rarely, death.

Neurocutaneous Melanosis, Lead Encephalopathy, Grisel's Syndrome

G9 Ruptured Cerebral Artery Aneurysm Mimicking Home Invasion and Assault

Albert Y. Chu, MD, MHS, and Luis A. Sanchez, MD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will understand a case of a 48-year-old white female with blunt force injuries who was found nude and semi-conscious in her ransacked residence. While the case was initially investigated as a possible home invasion and assault, the "victim" was ultimately diagnosed with a ruptured left posterior communicating artery aneurysm before dying.

This presentation will impact the forensic community and/or humanity by demonstrating that cases of ruptured cerebral artery aneurysm may rarely present with psychotic and/or violent behavior and that this behavior may in turn result in scene findings and injuries that may initially be confused with criminal activity and awareness of psychotic and/or violent behavior as an unusual presenting symptom of ruptured cerebral artery aneurysm and its potential to mimic assault at the scene.

A 48-year-old white female with a history of hypertension was found at her residence during a welfare check performed by her landlord and her best friend. The decedent was nude, semi-conscious, and "appeared to have been beaten." In addition, the house, which according to the landlord was typically kept very clean and tidy, was "trashed." EMS was activated, and the decedent was taken to the hospital.

Police arrived on the scene and investigated the case as an assault. The doors to the residence were locked but not secure and showed no signs of forced entry. Disarray at the scene was limited to the living room, kitchen, dining room, and bathroom; the two bedrooms were tidy. In the living room and dining room, various pieces of furniture and the television had been overturned, and broken dishes and glassware were strewn about. A lampshade had been torn to pieces. In the kitchen, the door of the oven had been removed and was located in an adjacent hallway, a bathrobe was in the refrigerator, and pieces of chicken were scattered throughout. Vacuum cleaner parts were in the washing machine. In the bathroom, vomit was on the floor and a can of insect repellent was in the toilet. No valuables were missing from the house.

At the hospital, the decedent was noted to have numerous contusions and abrasions, predominantly on the extremities. Toxicologic screening for drugs of abuse and alcohol performed the day of admission was negative. A sexual assault examination was also negative, and ultimately no evidence of semen was detected in any of the swabs or clothing collected. A computed tomography scan detected subarachnoid hemorrhage at the base of the brain, and angiography detected a ruptured left posterior communicating artery aneurysm. Despite a coil embolization procedure, the decedent never became coherent and expired nine days after arrival to the hospital. Because the attending physician thought that the decedent's blunt force injuries may have contributed to death, the decedent was brought to the Harris County Medical Examiner's Office for autopsy.

Autopsy examination confirmed the presence of subarachnoid hemorrhage associated with the treated left posterior communicating artery aneurysm. Injuries were limited to cutaneous injuries of the torso and extremities detected externally; no internal evidence of blunt force or penetrating trauma was identified. Additional findings included evidence of the decedent's known hypertensive cardiovascular disease including cardiomegaly with concentric left ventricular hypertrophy and myocyte hypertrophy and renal arteriosclerosis. The cause of death was classified as ruptured cerebral artery aneurysm due to hypertensive cardiovascular disease, and the manner was classified as natural.

Cerebral artery aneurysms are relatively common and have been reported as incidental findings in up to five percent of all autopsies. Typically, these aneurysms are asymptomatic unless they rupture, in which case most symptoms are due to the resulting subarachnoid hemorrhage. The classic presentation is that of "the worst headache in my life"; other common symptoms include loss of consciousness, seizures, meningeal signs, nausea and vomiting, drowsiness, dizziness, and cranial nerve deficits. Psychiatric symptoms, while previously reported, are unusual. This rare presentation of ruptured cerebral aneurysm resulted in a criminal investigation of possible assault.

Cerebral Artery Aneurysm, Psychosis, Assault

G10 Checking In to Check Out: The New Mexico Experience of Suicide Occurring in Hotels

Rebecca A. Irvine, MD, University of New Mexico, Office of the Medical Investigator, MSC 11 6030, 1 University of New Mexico, Albuquerque, NM 87131-0001*

After attending this presentation, attendees will have an awareness of features of hotel facilities, which may attract individuals contemplating suicide and the characteristic findings of the population that complete the act in this setting.

This presentation will impact the forensic community and/or humanity by delineating findings and behavior, which may assist in the determination of manner of death as suicide occurring in a hotel as well as facilitate discussion with the family under these circumstances. Possible points of intervention by hotel personnel are examined. Safety issues in the hospitality industry are underscored.

Hotels offer many advantages to the individual contemplating suicide, including but not limited to, privacy, an expected guarantee of timely discovery which will not traumatize loved ones, a place to stay when one has traveled to avoid recognition in their own community, sanctuary, a place to act out, neutral ground during disputes, or simply a high building with access to the roof. For others, it may be the end of a long road trip during which suicide was contemplated. Perhaps the sterility and depersonalized setting appeals to those with depression. All cases in New Mexico certified as suicide where the death occurred in a hotel setting or equivalent between 1995 and 2005 were reviewed for demographics and unique features (N=74, 2% of suicides certified in the State in this time frame).

This setting is preferred by White (73%) males (74%) between the ages of 30 and 50 (69%).

Firearm injuries are the method of choice in 42% of cases; no firearm suicides were immediately discovered because of the sound of the discharge of the weapon.

Drug intoxications accounted for 22% of the deaths; 22% of the non-illicit drug intoxications had detectable antiemetic substances. Although *Final Exit* recommends the use of an antiemetic in cases of contemplated overdose, it is also recommended that when death occurs in a hotel, a note of apology to the staff and a large tip be left. Neither of these was present in any of the cases.

There were a surprising number of somewhat unusual deaths, including cyanide poisoning, a stab wound of the leg (in a paraplegic individual), cold exposure, helium inhalation, jumping from a height (through a skylight into the lobby), and self-immolation.

Notes were present in 30% of cases and 18% of cases were considered to be highly organized (photographs, wills, insurance policies, "do-not-resuscitate" statements, Hemlock Society membership, religious material, etc.). Suicide in a hotel would seem to require at least some degree of planning and organization. Of the six deaths due to incised wounds, only one employed a weapon at hand (broken bottle). Of the five hangings, only two individuals brought a ligature to the scene; the remainder used linens or clothes hangers, items likely to be found in a hotel setting. In nine cases, there was multiple occupancy of the hotel room, although most of these were not witnessed.

The suicide notes in two cases indicated that the decedents had an advanced malignancy. At autopsy, neither case had an identifiable neoplasm. It is not known if this was a sincere belief on the part of the decedent or an attempt to console the family.

Cocaine was present in 12% of cases and was related to the cause of death in only one. It was by far the most common drug of abuse detected. Alcohol was present in 38% of cases, with 18% of these less than 0.04 mg/dL (possible bracing effect) and 36% greater than 0.2 mg/dL. It appears that when alcohol is consumed in this setting, the blood concentration is likely to be high. In three cases where death was attributed to illicit drug intoxication, all had suicide notes.

Decedents resided out of state in 28% of cases, almost half of these in states adjacent to New Mexico. Over half of the cases resided less than 100 miles from the scene, with 22% less than ten miles. It is possible that a polite question or inquiry by registering personnel regarding nearby residence may be a point of intervention.

There should be concern for the safety and welfare of personnel in the hospitality industry as these cases included physical domestic violence (x3), violent felons (x2), law enforcement stand-offs (x2), shooting outside the hotel room (x2) and a prison escapee. The case of self-immolation in particular could have caused a large-scale tragedy.

Suicide, Hotel, New Mexico

G11 Liver Laceration as a Result of Resuscitation in an Adult Man

Ellen G. Moffatt, MD, Office of the Chief Medical Examiner, 850 Bryant Street, San Francisco, CA 94103*

After attending this presentation, attendees will understand some of the more obscure complications of resuscitation in adults, in order to identify them at autopsy. This case is presented as an example of an injury that may be mistakenly interpreted as one that caused or contributed to death.

This presentation will impact the forensic community and/or humanity by differentiating injuries as the result of trauma and as the result of postmortem (or perimortem) resuscitation and reasons for their formation.

A 41-year-old male police officer on a nighttime training exercise collapsed suddenly. His fellow police officers immediately began CPR. His past medical history included controlled hypercholesterolemia, and complaints of left arm tingling the week prior to his death.

At autopsy, abrasions were on the center of the chest with fractures of the right fourth and fifth ribs at the sternum and the right fifth rib laterally. An 8.0 centimeter laceration was at the falciform ligament. Approximately 750 milliliters of unclotted blood was in the abdominal cavity.

Although the total cardiac weight (380 grams) was normal for his height and weight, the left ventricle measured 2.0 centimeters and the

septum thickness ranged from 2.0 centimeters to 1.1 centimeters. Histologically the heart showed focal cytomolysis and fibrosis adjacent to the bundle of His. Occasional parenchymal vessels had medial hypertrophy with narrowing of their lumens. Toxicology studies were negative. There was no evidence of head injury.

Liver lacerations are an uncommon, but recognized, complication in resuscitation in children. Liver lacerations as a complication of resuscitation in adults have been rarely reported, and are usually seen in patients receiving thrombolytic or anticoagulant therapy (1, 2). Other uncommon complications of resuscitation include tracheal rupture (3), lung herniation (4), heart rupture (5, 6) and gastric rupture (7,8). Other more common complications of resuscitation in adult include broken ribs, along with heart and splenic lacerations.

Proposed mechanisms of this injury include disparate size between rescuer and victim, and over-enthusiastic or incorrect placement of chest compressions.

Resuscitation, Complication, Laceration

G12 The Epidemiology of Sudden Cardiac Death in Young Decedent Medical Examiner Cases

Sharon M. Derrick, PhD, Stacey A. Mitchell, MSN, RN, and Luis A. Sanchez, MD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will understand the epidemiology of sudden cardiac death cases (SCD) presenting to a large medical examiner's office over a five year time span (2001-2005) resulting in increased understanding of the etiology of this cause of death.

This presentation will impact the forensic community and/or humanity by providing detailed medical and social history information recovered from a population of young individuals who died from sudden cardiac death. The resulting database is large enough to provide statistically significant data that can be used as a basis for further research. Dissemination of this information may support an emphasis on innovative screening and prevention practices targeting youth, ultimately contributing to decreased mortality from SCD in this at-risk segment of the United States population.

Sudden Cardiac Death (SCD) is the leading cause of natural death each year in the United States. This poster presentation will inform attendees regarding the epidemiology of SCD cases presenting to a large medical examiner's office over a five year time span (2001-2005), resulting in increased understanding of the etiology of this cause of death. SCD is often the result of untreated rapid ventricular tachycardia or ventricular fibrillation but it may be due to a variety of different conditions, including but not limited to acute myocardial infarction, coronary artery disease, cardiomyopathies, myocarditis, valvular heart disease, conduction abnormalities and drug toxicity (prescription and recreational).

SCD is a significant public health problem, the basis of which will be more effectively addressed through building a clear and accurate picture of young SCD decedents, thereby broadening innovative intervention projects to include previously underserved at-risk segments of the population.

A retrospective record review was conducted at the Harris County Medical Examiner's Office in Houston, Texas (HCME) that identified natural deaths reported to the HCME from 2002 through 2004. A full case review was performed for all of the cases in which cardiac death was listed as the primary cause of death after autopsy or external exam and in which the decedent was under the age of 50 years. Socially influenced factors, such as obesity (listed as contributory on the death certificate), tobacco use, and chronic ethanolism were noted for each case in addition to the decedents' medical histories.

Decedents whose cause of death was cardiac-related comprised 52% of cases presenting to the HCME during the 2002-2004 time period. Of those cases, 20% were under the age of 50, 72% were male and 51% were of Caucasian descent. A notable 43% were smokers. Obesity was listed on the death certificate as a contributing factor in 5% of the cases and chronic ethanolism contributed in 3%. Atherosclerotic Cardiovascular Disease and Hypertensive Cardiovascular Disease were diagnosed in 54% of those individuals under the age of 20 years. From 2002 to 2004, cardiovascular disease was shown to be the cause of death in 16 children between the ages of 12 and 18, with the majority collapsing while participating in athletic events. In light of these findings further study has been initiated at the HCME, expanding the study to the five year span of 2001-2005, reducing the upper age limit to 40 years, and exploring other case history factors for all of the cases such as cardiac enzyme levels, and prescription and recreational drug use. Body Mass Index was also calculated for each decedent. The analyzed results of the expanded findings are described in the poster presentation.

The important contribution of socio-cultural behaviors to health status has been documented in the medical and public health literature. Modifications of these behaviors, combined with the use of basic non-invasive cardiac diagnostic screening tests may greatly reduce the risk of SCD among younger individuals, such as student athletes. The HCME and other medical examiner offices can be instrumental in raising community awareness of SCD. A key goal of this public health education should be to promote the benefits of screening and prevention measures.

Cardiac, SCD, Epidemiology

G13 Significance of Blood Neopterin Measurement in Forensic Autopsy Cases

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After attending this presentation, attendees will understand how increased neopterin levels in postmortem blood samples identified with immunohistochemistry indicate non-specific viral infection.

This presentation will impact the forensic community and/or humanity by demonstrating how correct interpretation of postmortem blood neopterin levels can direct the postmortem examination in a cost-effective and efficient manner.

Definitive and specific diagnoses regarding infection with fatal viral pathogens are often hampered by the significant cost and labor associated with immunohistochemical staining. However, examination of non-specific markers for viral infection through high-throughput laboratory methods serves to direct the postmortem examination in a cost-effective and efficient manner. Neopterin, a pteridine released by macrophages, is a well-established marker of immune system activation. This study analyzes postmortem blood neopterin levels from multiple anatomic sites in an attempt to elucidate their accuracy in diagnosis of fatal viral infection. Medicolegal autopsy cases (n=521, 1-96 years of age, 366 males and 155 females) were examined. Causes of death were blunt injury (n=118), sharp injury (n=27), poisoning (n=26), drowning (n=30), fire fatalities (n=85), hypothermia (n=10), asphyxiation (n=30), hyperthermia (n=7), and natural death (n=143). Blood samples were collected at the time of postmortem examination from the subclavian and femoral veins and from the left and right heart. Neopterin levels were measured by high performance liquid chromatography. Neopterin levels greater than 500 pmol/mL correlated with fatal viral infection. Viral infection was

confirmed by histology and PCR. Levels of C-reactive protein, an additional marker of immune system activation, and neopterin were compared and a high correlation was observed in right heart blood. However, neopterin levels from all sites were significantly higher in cases of multiple organ failure that was not associated with viral infection than in other cases.

This study indicates that postmortem blood neopterin levels are both useful and cost-effective as a non-specific marker of viral infection. As the purpose of the postmortem examination is to provide the most specific information regarding cause of death possible, it is appropriate, though expensive, to elucidate the specific pathogen. Increased neopterin levels, in cases of possible viral infection, should trigger the immunohistochemical examination of tissue samples for specific viral antigens. However, neopterin levels may also be elevated in the face of drug use, chronic heart failure, and renal disease and caution should be used in interpreting blood neopterin content in the presence of these conditions.

Neopterin, C-reactive Protein, Viral Infection

G14 Evaluation of Nasopharyngeal Viral Swabs in Infants Dying of Natural Causes

Wendy A. Stroh, DO, and Deborah Kay, MD, Office of the Chief Medical Examiner, 400 East Jackson Street, Richmond, VA 23219*

After attending this presentation, attendees will be more informed on viral nasopharyngeal swabs in the infant population regarding frequency of use, results, and their impact on cause of death.

This presentation will impact the forensic community and/or humanity by elucidating the impact of viral postmortem testing in infants dying of natural causes.

This presentation will acquaint conference attendees with viral nasopharyngeal culture swabs use in an infant population less than one-year-old, dying of natural causes as well as the use of positive results in determining the cause of death. Information on the viral nasopharyngeal swab such as appropriate collection and submission techniques, sample rejection criteria utilized at the laboratory, and laboratory technology employed in determining results and its limitations of the technology is also provided.

The Office of the Chief Medical Examiner in Richmond, Virginia has used nasopharyngeal swabs to obtain viral culture samples since 2003. Viral nasopharyngeal culture swabs are performed in the vast majority of infant autopsies at this institution. They are routinely submitted along with blood and cerebrospinal spinal fluid cultures as part of the postmortem evaluation of all infants in whom Sudden Infant Death Syndrome is a consideration.

Autopsy charts on all infants under the age of one year dying of natural causes were reviewed. Data was tabulated on the total number of autopsies, total number of viral nasopharyngeal cultures obtained, submitted, resulted and rejected or not performed and reasons for rejection, total number of positive cultures including virus type detected and total number of negative results (no virus identified).

The viral nasopharyngeal swab kit contents are discussed. Appropriate procedures for obtaining optimal results in regards to sampling, storage of the specimen and proper submission are provided. Examples of rejection criteria are included as are factors that adversely affect culture results.

A discussion of the laboratory technology employed to obtain viral nasopharyngeal culture results is included. The limitations of the technology are listed. A list of types of viruses detected is included. Other technologies for obtaining viral culture results are mentioned as well as the limitations of these methods and factors affecting culture results.

Postmortem viral nasopharyngeal swab culture results are compared with antemortem results on infants of a similar age group. Factors, which

may contribute to differences in the results of the two groups, are postulated.

The influence of positive viral nasopharyngeal swab culture results on the cause of death is discussed including correlation of the viral results with other autopsy findings such as microscopy. Negative culture results and factors, which may contribute to negative results, are also mentioned. Brief case summaries on several autopsies with positive viral nasopharyngeal culture results are presented as examples of correlation of culture results with other autopsy findings to determine the causes of death.

Nasopharyngeal Swabs, Infants, Autopsy

G15 Succession of Microfungi in Grave Soil

Shari L. Forbes, PhD, University of Ontario Institute of Technology, 2000 Simcoe Street North, Oshawa, Ontario L1H 7K4, Canada; Trevor Lumley, PhD, Environment Canada, Environment Technology Centre, 335 River Road, Ottawa, Ontario K1A0H3, Canada; and David Carter, PhD, University of Nebraska Lincoln, 202 Plant Industry Building, Lincoln, NE 68583-0816*

After attending this presentation, attendees will understand that soil microfungi possess the potential to act as a tool to estimate extended postmortem and postburial interval.

This presentation will impact the forensic community and/or humanity by providing investigators with a novel method for estimating time since death in cases involving buried remains.

The estimation of postmortem interval (PMI) becomes increasingly inaccurate as decomposition proceeds. Estimating postmortem period in cases where a body is buried in soil is particularly difficult because soil typically prevents forensically important insects from accessing the body. Thus, the development of insect larvae is generally unavailable as a forensic tool in investigations involving burials. Therefore, a need exists to develop new techniques for estimating PMI of buried bodies and postburial interval (PBI). This need is particularly great for bodies associated with an extended postmortem period (months to years).

The forensic application of microfungi ecology has the potential to improve the estimation of extended postmortem periods. Like the macrofungi, microfungi respond to nutrient amendment. This response typically results in fungal proliferation and, as the nutrient source is utilized, a succession of microfungi taxa occurs. This phenomenon is similar to insect succession associated with cadaver decomposition on the soil surface. In addition, some microfungi, primarily from order Onygenales, possess the ability to access keratin as a food source. This might be of particular importance to forensic science, as a body in extended PMI primarily comprises keratinaceous material such as skin, hair and nails.

A study was carried out to identify fungal species present in grave soil over a period of six months following inhumation. In spring 2006 five pig (*Sus scrofa*) carcasses were placed in separate shallow graves (40-50 cm) and covered with soil. Carcasses were exhumed at monthly intervals for the 6-month period. Soil was collected from the walls and base of each grave. These soils were sprinkled or diluted in water and spread onto tapwater, cornmeal, or Mycosel® agar plates containing the antibiotic chloramphenicol. This antibiotic was used to suppress the growth of bacteria and rapidly proliferating fungi that can overwhelm the fungi of interest.

Following the first exhumation, minimal decomposition had occurred and the carcass was classified as being in the fresh/bloat stage. As expected, there was no discernable difference between microfungus communities in control soil samples (taken at four depths one meter away from the cadaver) and soil taken from various microsites in contact with the cadaver. Communities were dominated by *Trichoderma* spp., *Mucor* spp., *Acremonium* spp., *Sordaria fimicola*, and coelomycete spp.; all common soil microfungi. These findings were able to provide a thorough background of the microfungi community in the soil.

Following the second exhumation, considerable decomposition had occurred and the carcass was classified as being in the active/advanced decomposition stage. Discernible differences in the microfungi community were apparent between grave soil and control soil samples, particularly with regard to the soil nematode community. This stage of decomposition is associated with an increase in bacterial-feeding nematodes that are then succeeded by fungal-feeding nematodes.

Exhumations will continue for the remainder of the trial and results for the six month period will be presented. Based on the preliminary results, it is anticipated that communities of nematophagous fungi will change in response to shifts in nematode community composition. These changes should be predictable over time. As a result, community structure data for nematophagous fungi has the potential to act as an additional forensic tool in estimating PMI and PBI of buried remains.

Microfungi, Grave Soil, Postburial Interval

G16 Improved Estimation of Postmortem Interval With Multiple Protein Markers and Improved Analytical Methods

Behnoush Memari, MS, Kenneth G. Furton, PhD, and Alberto Sabucedo, PhD, Florida International University, Department of Chemistry and Biochemistry, 11200 SW 8th Street University Park CP-345, Miami, FL 33199*

After attending this presentation, attendees will learn about the development and utility of cardiac Troponin I (cTnI) and Troponin T (cTnT) as time since death markers for PMI Estimation.

This presentation will impact the forensic community and/or humanity by improving the accuracy in postmortem interval estimates. PMI provides crucial information required in many criminal, civil, and forensic investigations.

Time since death markers have lagged behind advances in forensics technology. Knight (1994) explains, "regrettably, the accuracy of estimating the postmortem interval (PMI) has by no means kept pace with the enormous strides made in technological sophistication." Early work on time since death focused on postmortem temperature measurements and algorithms to model postmortem cooling behavior. Current technology is still largely based on postmortem temperature methods similar to those described in the 1800's. Marshall summarized the temperature measurement method as follows, "It would seem that the timing of death by means of temperature can never be more than an approximation."

Biochemical markers for estimating time since death offer the possibility of increased accuracy and reliability in time since death estimates. Cardiac Troponin I (cTnI) and cardiac Troponin T (cTnT) are heart tissue proteins and selective markers of cardiac muscle damage. Investigation of these proteins as a marker for time since death shows great promise in mammalian heart tissue. cTnI and cTnT are found as intact protein in freshly sampled tissue at the onset of death, (T_0). These proteins are good substrates for several enzymes released in cardiac tissue upon death (necrosis). The proteolytic breakdown of these proteins by proteases in postmortem cardiac tissue is exploited to determine the postmortem interval. Both bovine and human heart tissue show similar banding patterns upon degradation. This technique takes a small sample of cardiac tissue that is homogenized and extracted with magnetic microparticles. The proteins are separated by SDS-PAGE electrophoresis and selectively visualized by Western blot. The Western blot is probed with mouse monoclonal antibodies against cardiac TnI and TnT. This step is followed by an anti-mouse conjugate labeled with alkaline phosphatase that is developed with a precipitating colored substrate. The degradation pattern of cTnI and cTnT is monitored using this bioanalytical protocol. The area of the bands within a lane is quantitated by scanning and digitizing the bands. Project methodology will be migrated to more

automated system such as capillary electrophoresis. This technique exploits the use of separation of the complex fraction isolated followed by detection of the fragments.

The results show a linear relationship between percent protein degraded and the log of postmortem time. A fresh "reference" human heart tissue obtained at time T_0 was incubated to obtain a temporal degradation profile. Comparison of human cardiac tissue samples with unknown time of death can be evaluated qualitatively against the "reference" human heart tissue. The time of death can be estimated by matching the "degradation fingerprint." Similarly, a calibration curve ($r = 0.95$) can be obtained with the percent cTnI degraded plotted against the log of the time postmortem using the reference human heart tissue. This curve can be used to estimate the time since death relative to the "reference" tissue based on the percent degradation. Data indicates that the degradation of cTnI in heart tissue shows very specific bands during a postmortem interval of a week. Troponin T is more stable in comparison to Troponin I so the degradation of cTnT should be longer. Data combined from cTnI and cTnT could be used for extended PMI estimate. Human cardiac tissue samples frozen at known time of death were analyzed by both semi-quantitative and qualitative techniques and both show similar agreement with the known time of death.

Overall, the data demonstrates that this technique represents a major advance in time of death determination providing a reliable semi-quantitative biochemical marker from a protected organ versus estimates based on direct temperature measurements. Tissue cardiac Troponin I and Troponin T shows excellent characteristics as time of death markers in the extended postmortem interval that is difficult to estimate with current methods.

TnI (Troponin I), TnT (TroponinT), Postmortem Interval (PMI)

G17 Drowning of a Child With a Cardiac Fibroma of the Interventricular Septum

Darshan R. Phatak, MD, and Luis A Sanchez, MD, Harris County Medical Examiner Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will have a better comprehension of the nature of the presentation of this potentially fatal mesenchymal cardiac tumor, an understanding of the gross and microscopic pathology and the physiology of potentially fatal disturbances to cardiac function resulting from the size of the tumor and location in the heart.

This presentation will impact the forensic community and/or humanity by demonstrating why it is strongly recommended that those involved in the determination and certification of the cause and manner of death familiarize themselves with cardiac tumors" presentation, pathology and lethal potential and remember to include them in their differential diagnosis when confronted by cases such as this one.

This presentation will have a positive impact on pathologists, coroners, medical examiners, other autopsy practitioners and humanity at large as it can heighten general awareness towards a potentially treatable cardiac tumor that may be found either incidentally or strike down children, a vulnerable population subset, without warning.

A four-year-old Hispanic female child drowned in a swimming pool at a family gathering and had a past medical history of cardiomegaly and a heart murmur which were diagnosed neonatally, yet reportedly neither treated nor followed medically since infancy. Prior to death, the decedent had no health complaints or behavioral changes. At the scene, the decedent's stomach was bloated and clear fluid was reported in the respiratory tract.

Pertinent autopsy findings included cerebral edema, serous fluid within the pleural cavities, pneumonomegaly, and hepatosplenomegaly. Cardiomegaly and a fibroma of the interventricular septum were also found at autopsy. Toxicological tests were negative.

The majority of primary cardiac tumors are benign, with fibromas representing five percent of all cases. In the pediatric population, it is the second most common primary tumor of the heart after rhabdomyomas. The tumor also has a predilection to form within the interventricular septum and grows in size rapidly. Despite the lack of aggressive behavior or any metastatic potential, fibromas of the heart can interfere with normal physiologic function due to the interdigitation of tumor cells around and between cardiomyocytes and cardiac blood vessels and the possibility of entrapment and disruption of the cardiac conduction system that can result in a fatal arrhythmia. In addition to immediate local effects, the physical alteration of the cardiac muscle also results in pathologic changes of the other organ systems that will also impair the health of the individual over time.

The tumor is often surgically resectable or treatable by heart transplantation so therefore, proper diagnosis and prompt treatment can be lifesaving. Cardiac fibromas may also occur in the setting of the nevoid basal cell carcinoma syndrome (Gorlin-Goltz syndrome), so it can be beneficial for parents and other relatives to know the diagnosis. The most important lesion in the differential diagnosis is fibrosarcoma, a malignancy that is rare in the heart and in the general pediatric population. In a primary cardiac tumor, it is also of crucial importance to rule out a metastasis from a primary tumor of another location, as the treatment will vary.

This case of cardiac fibroma serves as a good example of a primary cardiac tumor's potential for fatal presentation in a child. Sometimes children with congenital heart abnormalities do not receive close monitoring of their health under a physician's care, and it is strongly recommended that those involved in the determination and certification of the cause and manner of death familiarize themselves with cardiac tumors' presentation, pathology and lethal potential and remember to include them in their differential diagnosis when confronted by cases such as this one.

Cardiac, Fibroma, Drowning

G18 Estimating Time of Death From Livor Mortis Patterns: A Case Presentation

William Massello III, MD, Office of the Chief Medical Examiner, 6600 Northside HS Road, Roanoke, VA 24019*

After attending this presentation, attendees will understand the forensic importance of recognizing patterns of lividity produced by articles of clothing and of documenting these patterns of lividity photographically. Patterns of lividity can be useful in estimating the time of death. Attendees will also come to appreciate how a pains taking analysis of postmortem photographs can have relevance to the application of the proper criminal charges.

This presentation will impact the forensic community and/or humanity by demonstrating how both scene photography and postmortem photography of the remains, when used in conjunction with computer resources, can be valuable in estimating the time of death. It also demonstrates that a careful analysis of patterns of lividity, even in postmortem digital photographs, can be important in providing evidentiary material for use in helping resolve important questions in criminal law.

Following this case presentation, the attendees will understand the forensic importance of recognizing patterns of lividity produced by articles of clothing and of documenting these patterns of lividity photographically. Additionally, it will be shown how these patterns of lividity can be useful in estimating the time of death. An understanding of the importance of postmortem photography as a tool in death investigation will be underscored. Attendees will also come to appreciate how a pains taking analysis of postmortem photographs can have relevance to the application of the proper criminal charges.

This case involves a 19-year-old white female who was a still-life photography model participating in a pornographic photo shoot in a studio in a small rural community. Following a photo shooting session, she voluntarily, orally took an unknown amount of a proprietary liquid morphine preparation and lay down to take a nap. While she was asleep on the bed, the photographer took some additional photographs and, later, by his own admission, performed sodomy on the individual while she was asleep. Approximately one hour later, he noticed that she wasn't breathing and called the local rescue squad. She was rushed to the hospital, where it was determined that she was pulseless, apneic, cold, and blue. It was determined by postmortem examination and toxicology that she had died from a lethal concentration of morphine, in combination with two other benzodiazepines, dextromethorphan in the presence of a residual concentration of cocaine and its metabolite, benzoylecgonine. Questions arose during the investigation concerning whether the decedent was alive and/or was capable of consent during the purported act of sodomy by the photographer.

Postmortem police scene photographs and digital photographs taken at the studio by the photographer while the decedent was asleep on the bed were reviewed. It was revealed that numerous patterned lividity markings, made by the decedent's clothing, had persisted for several hours after the clothing items had been removed. These photographs were matched up with the "date and time modified" column on the computer explorer window. They demonstrated that the decedent had expired at least more than an hour before the photographer admitted to sodomizing her. This finding was instrumental in showing that charges of non-consensual sexual assault, to include animate object penetration, were not appropriate in this case, because the decedent was already dead at the time the act of sodomy and digital insertion were performed.

Time of Death, Livor Mortis, Digital Photography

G19 Dispersion of Hesitation Marks and Defense Wounds: A New Criterion of Differentiation of Sharp Force Suicide and Homicide

Stéphanie Racette, BSc, Célia Kremer, MSc, Anne Desjarlais, and Anny Sauvageau, MD, Laboratoire de Sciences Judiciaires et de Médecine Légale, 1701, Parthenais Street, 12th floor, Montreal, Quebec H2K 3S7, Canada*

After attending this presentation, attendees will be introduced to a new criterion of differentiation of hesitation marks and defense wounds in sharp force injuries.

This presentation will impact the forensic community and/or humanity by providing new insight in the evaluation of hesitation marks and defense wounds.

In evaluating manner of death, forensic pathologists often rely on widely accepted criteria of differentiation at autopsy. For example, the presence of hesitation marks or defense wounds in sharp force injury cases has been accepted as a criterion of differentiation between sharp force suicide and homicide.

With this study, the authors wanted to enrich the description of hesitation marks and defense wounds. The authors hypothesize that (1) hesitation marks would predominantly be present on inner surface of upper limbs while such predominance would not be found for defense wounds, (2) a possible left predominance in hesitation marks could be found, considering the higher proportion in the general population of right-handed person and finally that (3) hesitation marks and defense wounds would show a different pattern of dispersion on upper limbs.

Over a 5-year period, in the Quebec province (Canada), all cases of suicidal and homicidal sharp force injury presenting hesitation marks (n=43) and defense wounds (n=91) were retrospectively reviewed. For

each case, hesitation marks or defense wounds were drawn on an upper limb chart divided into 12 sections covering the upper arm to the hands. The total amount of lesions for each section was compiled as well as the total amount of wounded sections. For all suicidal victims, a general chart of upper limbs was done by superimposing every chart with hesitation marks. The same was achieved with homicidal victims for defense wounds.

- (1) Sharp force victims of suicide presented a significant higher average amount of hesitation marks on inner aspect of upper limbs than on exterior surface ($p < 0.05$). In victims of homicide, no difference was revealed between inner and exterior average amounts of defense wounds.
- (2) In terms of left and right comparison, a left predominance was not found for hesitation marks cases or for defense wounds cases. In fact, in suicide cases, the average amount of hesitation marks was the same on each inner side of upper limbs.
- (3) Graphical superimposition of hesitation marks/defense wounds for all victims visually revealed low dispersion of hesitation marks and high dispersion of defense wounds. This was statistically confirmed by comparing the average amount of hesitation marks/defense wounds and the average total number of wounded sections. For both inner and exterior aspects of upper limbs, the average total number of wounded sections was significantly higher for defense wounds compared to hesitation marks ($p < 0.05$), while no significant difference was revealed for the comparison of average amount of wounds. In other words, for a similar average amount of hesitation marks and defense wounds, the average number of wounded sections on upper limbs revealed to be higher for defense wounds than for hesitation marks. Thus, defense wounds show higher dispersion on upper limbs compared to hesitation marks.

This retrospective study of hesitation marks and defense wounds first confirmed the initial hypothesis of predominance of hesitation marks on inner surface of upper limbs. However, while it is often said that sharp force victims, considering the proportion of right-handed person in the general population, are more likely to present hesitation marks on their left upper limb, this five year study failed to confirm such predominance. Consequently, the authors discourage the use of a left-right characteristic in the evaluation of hesitation marks and defense wounds. The pattern of dispersion of hesitation marks and defense wounds suggests a difference in the pattern of dispersion as a new criterion for hesitation marks and defense wounds.

Hesitation Marks, Defense Wounds, Sharp Force Injury

G20 Neck and Scleral Hemorrhage Due to Drowning

Russell T. Alexander, MD, and Jeffrey M. Jentzen, MD, Milwaukee County Medical Examiner's Office, 933 West Highland Avenue, Milwaukee, WI 53233*

The goal of this presentation is to review a case of drowning associated with extensive bilateral scleral and neck hemorrhage.

This presentation will impact the forensic community and/or humanity by discussing the occurrence and possible mechanisms for the creation of scleral and neck hemorrhage in drowning related deaths.

The decedent was a 30-year-old male who was found with his 5-year-old stepson at the bottom of a nine foot deep hotel pool after hotel workers noted two of the decedent's other young children playing unattended on the steps in the shallow end of the pool. The decedent and his stepson were pulled unresponsive from the pool. Firefighters arrived at the scene and started CPR after finding the decedent pulseless and not breathing. After 30 minutes of resuscitative efforts, he was declared dead at the scene. The child was taken in "critical" condition to a nearby children's hospital, and was discharged the next day with no neurological deficits. At

that time, the stepchild reported that the last thing he remembered was falling into the pool.

The decedent's wife last saw him alive 2.5 hours before he was found. She thought he and the three children were going back to their room to watch television. She did not know why they would go to the pool, since he and the children were unable to swim. An investigation by law enforcement found no evidence of foul play.

A "foam cone" was at the mouth and nose of the decedent at the scene. At autopsy, there was marked bilateral scleral hemorrhage. No abrasions or contusions were on the anterior or posterior neck. Internally, the lungs were hyperinflated. Frothy fluid filled the airways and exuded from the cut surfaces of the lungs. The sphenoid sinus contained 3 ml of bloody fluid. Blood was in the mastoid air cells bilaterally. The right ventricle of the heart was dilated and the thyroid gland was markedly congested. A layered anterior neck dissection revealed hemorrhage on the surface of multiple strap muscles that was confined to the fascial surfaces of the muscle; sectioning did not reveal contusion within the substance of the muscle. A comprehensive toxicology screen did not detect alcohol or drugs within iliac blood. A vitreous electrolyte screen was within normal limits. The cause of death was determined to be drowning. The manner of death was accident.

Despite the assertion that anterior neck muscle hemorrhage "do not occur in drowning and should always raise the suspicion of foul play" (Spitz, 2006), others have reported this finding (Carter et al., 1998; Puschel et al., 1999). This hemorrhage has been attributed to hypostasis (livor mortis), muscular injury due to violent neck movements or an artifact of decomposition (Carter et al., 1998). Conjunctival and facial petechiae are due to increased cephalic venous pressure; a phenomena that may be exaggerated by coughing, gagging or a struggle that increases cardiac output and blood pressure (Ely and Hirsch, 1999).

Increased central venous pressure due to coughing and gagging, as well as increased cardiac output and blood pressure during the struggle of the drowning process, led to the scleral and neck hemorrhages described in this case. The elevated central venous pressure would be transmitted through valveless veins to the neck musculature as well as the head. Such elevated pressure could also cause right heart dilation and congestion of the thyroid gland.

Strangulation can result in neck and scleral hemorrhages similar to those described in the current case. Direct trauma to the neck during strangulation would typically cause hemorrhage within the substance of the muscle rather than just fascial hemorrhage. When a body recovered from water has these findings, it is imperative to consider all scene, autopsy, and toxicology findings to arrive at the proper cause and manner of death.

This case presentation demonstrates that drowning can result in significant neck and scleral hemorrhage, probably due to increased central venous pressure during the drowning process.

Drowning, Hemorrhage, Strangulation

G21 Papillomacular Folds: Whiplash Maculopathy or Postmortem Artifact?

Patrick E. Lantz, MD, Wake Forest University Health Sciences, Department of Pathology, Medical Center Boulevard, Winston Salem, NC 27157*

After attending this presentation, attendees will understand the usefulness of postmortem monocular indirect ophthalmoscopy in differentiating postmortem fundal artifacts from pathologically significant retinal folds.

This presentation will impact the forensic community and/or humanity by demonstrating that horizontal, hypopigmented, non-hemorrhagic retinal folds represent a postmortem artifact and must not be misinterpreted as retinal injury from putative vitreoretinal traction associated with whiplash or presumed shaking (Shaken Baby Syndrome or Inflicted Childhood Neurotrauma).

Clinically, whiplash maculopathy has been associated with three subtle macular disturbances following head/neck trauma from hyperextension/flexion. These include mild reduction of central visual acuity or paracentral scotoma, grayish swelling of the foveal zone and a small pit or depression in the fovea. The retinal opacity usually resolves and visual acuity most often returns to 20/20 but the foveal depression invariably remains. No specific pathophysiologic mechanism has explained the development of traumatic retinopathy after this indirect ocular trauma. Some authors favor a mixed mechanism, mechanic and vascular, to explain these alterations while others postulate that local microcirculatory disturbances are the cause of the retinopathy as opposed to the systemic disturbance associated with Purtscher's retinopathy.

A recent publication claimed the first account of the macroscopic and microscopic pathologic findings that they believed were the result of whiplash maculopathy and retinopathy (*Forensic Sci Med Pathol* 2005;1:19-25). The macular and retinal findings were found at autopsy in 20-year-old woman who suffered fatal head and neck injuries following a roller-coaster accident. Both eyes had horizontal folds extending temporally from the optic disc just beyond the fovea presumably secondary to vitreous traction.

However, the horizontal hypopigmented, non-hemorrhagic papillomacular retinal folds depicted in this case report represent postmortem artifacts readily apparent by postmortem monocular indirect ophthalmoscopy as evidenced by the following case. A 4-month-old infant presented to the Emergency Department of a regional medical center apneic and pulseless. Resuscitative efforts re-established cardiac activity but mechanical ventilation was required. Direct and indirect ophthalmoscopy in the Pediatric Intensive Care unit did not reveal any fundal hemorrhages or retinal folds. Death occurred 56 hours after admission. Postmortem monocular indirect ophthalmoscopy performed four hours after death confirmed clinical fundoscopic findings; however, the following morning, 21 hours after death bilateral hypopigmented, non-hemorrhagic retinal papillomacular folds had formed that were grossly and microscopically similar to the retinal folds attributed to whiplash maculopathy.

Subsequent examination of infants and adults who have died from natural disease processes has demonstrated that these artifactual papillomacular retinal folds initially form a few hours after death as retinal elevations around the fovea centralis then extend nasally and temporally. This fairly uniform sequence has been as demonstrated by serial postmortem fundal imaging utilizing monocular indirect ophthalmoscopy. It is imperative that this postmortem artifact is not misinterpreted as retinal injury from putative vitreoretinal traction associated with whiplash or presumed shaking (Shaken Baby Syndrome or Inflicted Childhood Neurotrauma).

Whiplash Maculopathy, Postmortem Monocular Indirect Ophthalmoscopy, Postmortem Artifact

G22 To Dye or Magnify! A Proposal to Study the Efficacy of Toluidine Blue Dye vs. Colposcopy in the Postmortem Anogenital Examination

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The goals of this presentation is to determine if toluidine blue is a reliable or useful adjunct in the postmortem genital examination; to describe a baseline study protocol that compares results from photocolposcopy at 7.5X and 15X magnification vs. photocolposcopy plus the addition of toluidine blue dye; and to better understand the nature and appearance of the postmortem anogenital anatomy.

This presentation will impact the forensic community and/or humanity by demonstrating an increase in the reliability and consistency

of postmortem anogenital examination techniques; and increasing in the diagnostic acumen of the forensic examiner.

Recent studies have focused on the application of a 1% solution of toluidine blue dye, a general nuclear stain, as a practice standard for the medical-legal examination of *living* sexual assault victims. Specific recommendations, e.g., the sequence of the dye application during the pelvic examination, have been delineated and advocated. Some authors and numerous practitioners recommend application of the nuclear stain *prior* to insertion of the speculum. This is based on the assumption that that the nuclear stain will delineate iatrogenic injury from pre-existing traumatic findings due to a sexual assault. In one study of antemortem sexual assault cases, Jones, Dunnuck, Rossman, et al described a 3.7% incidence (1/27 cases) where one additional genital injury was delineated via toluidine blue, after speculum insertion and removal by the examiner. This injury was located on the posterior labia minora.

In a study by Hochmeister, Whelan, et al., (JFS, 1997), there was no effect on either PCR or RFLP recovery when vaginal swabs were exposed to the dye. However, the sample size was limited to only five women and postcoital swabs were collected within six hours of coitus. In California, the medical-legal protocol recommends that dye application be deferred until *after* collection of biological specimens.

A review of the original methodologies from Richart (1963), Collins (1966), Lauber & Souma (1982), and McCauley (1987) was done by Crowley and Peterson (*To Dye or Not to Dye*, AAFS, 2005). Variability in interpretation of results in antemortem patients may be due to *many* factors. Toluidine blue is specific for zones of parakeratosis; thus positive results can be due to inflammatory, benign, or malignant vulvovaginal diseases. Twenty-three different benign vulvovaginal conditions, in addition to the presence of cervical mucous, will yield false positive results with application of this dye *in vivo*.

A paucity of data exists on the "normal" appearance of the anogenital tissues during the postmortem interval. Detailed observation and baseline studies are ideally done with colposcopy and documentation via magnified photos, to facilitate peer review. Colposcopy has been thoroughly utilized by numerous authors to enable the study of both normal and abnormal findings in both child and adult sexual assault victims since the late 1980s. The protocol for detailed postmortem inspection and the methodology for an evidentiary anogenital examination have been previously described (Crowley, JFS, 2004). The correct application and interpretation of results/findings were thoroughly described by the earlier authors (Richart, Collins, Lauber & Souma, and McCauley). The intensity of the stain is correlated to the nuclear density of the tissues. Most of the earlier authors reiterated that the proper decolorization of the dye was the most important part of the methodology. Conventional methodologies vary widely, as do the post-assault time intervals for application of the dye. Another salient factor in any discussion of the efficacy of a nuclear stain vs. colposcopy is the anatomic site to which the dye can be appropriately applied. Although used by the earliest authors for diagnosis of cervical and vulvar neoplasias, Lauber and Souma, in 1982, first described its use for evaluation of sexual assault victims and comparison to a control group of consenting women. It is important to remember that at that time, colposcopy was not widely available for examination of this population. These authors also limited the application of the dye to the posterior fourchette, an area that is histologically comprised of skin-like stratified squamous epithelium.

As mentioned previously, subtle findings may be an examiner issue (Slaughter, personal communication, 2004). Many programs do not routinely include follow-up examinations in their protocol. Without incorporation of follow-up examinations, it may be extremely difficult to evaluate findings such as localized redness and swelling. In all cases, both antemortem and postmortem, it is essential to employ the highest standards, in order to differentiate traumatic findings from either preexisting benign vulvovaginal conditions or postmortem artifact. Even experienced sexual assault examiners, whose expertise is confined to antemortem cases, may confuse normal postmortem changes or findings secondary to the cause and manner of death with traumatic lesions that are consistent with penetrating injury, i.e., sexual assault.

Materials and Methods: Using the mobile system of technology described by Crowley (*JFS*, 2004), the author proposes a baseline study of postmortem genital examinations with concomitant application of a 1% solution of toluidine blue dye. Utilizing colposcopy at 15X magnification, no injuries were noted in living sexual assault victims via the nuclear stain that had not already been visualized with colposcopy (Slaughter, Brown, Crowley, & Peck, *Amer. J of Ob Gyn.*, 1997).

Careful scrutiny and photo documentation with colposcopy at 7.5X and 15X should be done *prior* to speculum insertion and anoscopy. After the speculum (and anoscopic) examination, the dye can be applied to the following sites: lateral aspects of the **labia majora**, **posterior fourchette**, **fossa navicularis**, **perineum**, and the **perianal** area up to, but not beyond the area of the anal verge. The labia minora are moist and the epithelium is similar to mucous membrane. Only the lateral aspects are covered by skin. Thus, any positive findings at this anatomic site must be interpreted with caution. Application of the dye and scrupulous decolorization should then be done in the manner described by the original authors. These anatomic sites are selected based on histological composition and applicability to the techniques that were thoroughly described by previous authors, Richart (1963), Collins (1966), Lauber & Souma (1982), and McCauley (1987).

Another salient factor that requires further study and comparison to photocolposcopy is the interval of applicability for both antemortem and postmortem cases. Currently, a wide variation exists in standards. In non-genital sites, toluidine blue has been shown to yield positive uptake in granulation tissue. The great variety of normal artifact often present in postmortem cases presents many additional challenges. It is crucial that examiners avoid working in a vacuum. Often forensic nurse examiners are called to examine postmortem cases because of their expertise in living sexual assault cases. It is imperative that they consult and collaborate with the forensic pathologist, especially if their expertise has been previously confined only to the antemortem arena. Normal postmortem artifact has been misinterpreted as trauma and the additional use of toluidine blue will likely only complicate interpretation until it has been sufficiently studied. In equivocal cases, the forensic pathologist can remove the relevant tissues en bloc for dissection and microscopic evaluation. Prior to this, it is useful to have an initial in situ examination via colposcopy of the anogenital tissues.

The ultimate goal is to better visualize the anogenital tissue in the postmortem patient, in order to improve the understanding of what is normal, and what is not, at various postmortem intervals. It is possible that the application of toluidine blue dye may then enhance, for pictorial documentation.

Colposcopy, Toluidine Blue Dye, Forensic Nurse Death Investigator

G23 Virtopsy - Virtual Autopsy, Where We Go?

Michael J. Thali, MD, University Bern, Centre Forensic Imaging and Virtopsy, Buehlstrasse 20, Bern, Bern 3012, Switzerland*

After attending this presentation, attendees will learn about the newest imaging technologies for forensic medicine.

This presentation will impact the forensic community and/or humanity by discussing the upcoming cutting edge developments and steps in visual documentation and reconstruction of forensic cases. Therefore there will be a great impact of the paper. Invasive “body opening” autopsy is today’s state of the art in human postmortem investigation. Modern cross section techniques can supplement and may replace autopsy to some extent with several improvements for the forensic workflow.

A combination of 3D optical and photogrammetric surface scanning with full body CT scans as well as postmortem MRI investigations to correlate the radiological findings with the forensic findings documented in traditional autopsy performed afterwards is discussed. Using the Armed Forces Institute of Pathology (AFIP) design comparison approach, well

known from clinical radiology and pathology correlating radiological and pathological findings, different forensic morphological findings are presented. Additionally the application of micro CT and Magnetic Resonance Microscopy is introduced for the forensic use.

The new possibilities that are based on the combined data sets of forensic corpses (visible human in forensics) such as real data based forensic virtual reconstruction and application of “morphological fingerprints” are demonstrated. The article gives an overview on postmortem application of 3D surface scanning and radiological cross sectional scanning using CT and MRI in forensic medicine by correlating imaging appearances of essential forensic findings to their appearance in traditional autopsy.

This paper presents the newest developments in postmortem biopsy, postmortem angiography, and the MRI whole body imaging using “Total imaging Matrix.”

Virtopsy, Virtual Autopsy, Imaging

G24 Female Firearm-Related Suicides: A Reappraisal

Kevin D. Whaley, MD, Anna Noller, PhD, and William T. Gormley, MD, PhD, Central District, Office of the Chief Medical Examiner, Commonwealth of Virginia, 400 East Jackson Street, Richmond, VA 23219*

After attending this presentation, attendees will recognize that suicides by women using firearms, including shotguns are not rare and may be increasing in incidence.

This presentation will impact the forensic community and/or humanity by demonstrating the increasing incidence of self-inflicted gunshot and shotgun wounds by women.

After attending this presentation, attendees will appreciate the increasing incidence of female firearm-related suicide. Moreover, they will become familiar with the most common risk factors associated with these cases.

When women die from apparently self-inflicted firearm wounds, especially shotgun wounds, many citizens, family members, and death investigators are very suspicious that the death is really a homicide. This presentation will impact the forensic community, particularly forensic pathologists, and medicolegal death investigators, by facilitating accurate and efficient determination of the manner of death in female firearm-related suicides. Furthermore, proper classification of these deaths as suicides will also result in a more efficient expenditure of time and other resources with regards to law enforcement and the judicial system.

Notwithstanding increasing data to the contrary, female suicides are often stereotypically associated with less violent means (i.e., poisoning, hanging, carbon monoxide) while their male counterparts are stereotypically associated with more destructive means (i.e., firearms, jumping from heights, motor vehicle accidents).

Despite being historically associated with male suicide, a retrospective review of female suicides occurring in Virginia from 2000 – 2005 revealed a significant percentage of female decedents utilized a firearm. This study reviewed the case files of all female firearm-related suicides from 2000 to 2005 at the Richmond District Office of the Chief Medical Examiner. Additional data was gathered from the other three districts with regards to the incidence female firearm-related over this five year period. Data collected from each case included the age, race, comorbidities, socioeconomic status, and substance abuse history, type of firearm utilized, firearm availability, and whether or not other methods of self-destruction accompanied the firearm injury. The demographics and risk factors associated with female firearm-related suicides differ from those associated with their male counterparts. Appreciating these differences will facilitate accurate and efficient medicolegal death investigation of female suicides involving a firearm.

Of particular concern is a gradual increase in the incidence of firearm-related female suicides annually. In Virginia, the incidence of firearm-related female suicides has increased by approximately ten percent over a four-year period. Moreover, of firearm-related female suicides, a significant percentage involves a shotgun rather than a handgun or rifle.

The presentation will include case examples that illustrate the most common scenarios involving female firearm-related suicide.

Shotgun, Suicide, Women

G25 Agonal Sequences in Four Filmed Hangings: Analysis of Respiratory and Movement Responses to Asphyxia by Hanging

Anny Sauvageau, MD, and Stéphanie Racette, BSc, Laboratoire de Sciences Judiciaires et de Médecine Légale, 1701 Parthenais Street, 12th Floor, Montreal, Quebec H2K 3S7, Canada*

The goal of this presentation is to first review the literature on physiological responses to asphyxia by hanging in human and animal literature, and then to compare such data to four cases of filmed hanging. In the conducting of investigations and trials, forensic pathologists are often asked to discuss the body's responses to hypoxia/anoxia and their temporal relationship to the timing of asphyxial deaths. However, those questions are difficult to answer considering the actual paucity of research literature.

This presentation will impact the forensic community and/or humanity by providing new insight into the physiopathology of human asphyxia.

Introduction: The human pathophysiology of asphyxia by hanging is still poorly understood, despite great advances in forensic science. Even though some studies have been conducted on animals, the extent to which those results can be applied to human is uncertain. Since experimental protocols are, of course, out of the question, filmed hangings hold the key element to answer questions regarding the sequence of events leading to death in the context of human asphyxia.

Methods: A total of four filmed hangings were analyzed: one suicide filmed by a video camera, two autoerotic deaths and one suicide in custody filmed by a surveillance camera. Those filmed hangings were compared in terms of loss of consciousness, convulsions, decortication, and decerebration rigidity, loss of muscle tone, last muscle movement, and respiratory responses. Two independent judges scored the time frame at which each of these responses occurred.

Results: With the time 0 representing the onset of hanging, rapid loss of consciousness was observed (at 13-18s), closely followed by appearance of convulsions (at 15-19s) in all cases. Within the first minute (19-21s in most cases, 46s in one case), decerebration rigidity was observed. Two phases of decortication rigidity was also noted, the first one being relatively sudden and quick (onset at around 1min00s -1min 08s in most cases, 21s in one case) while the second one (onset between 1min04s - 1min32s) extended for about one minute, with an observed climax of rigidity about 20 seconds after its onset. Appearance of loss of muscle tone varied between 1min 38s and 2min 47s, with last isolated muscle movement occurring between 2min 15s and 4min 10s. Similar patterns between cases was observed for respiratory responses: onset of very deep respiratory attempts between 20 and 22 seconds, last attempt between 2min 00s and 2min 04s for an average interval of 1min 40s to 1min 42s. Overall, total hanging time before apparent death was between 2min 47s - 4min 10s.

Conclusion: Despite differences in the types of hanging, similarities could be revealed regarding rapid loss of consciousness and onset of

convulsions, pattern of decortication rigidity and respiratory responses. To date, this is a unique study of agonal movements in asphyxia by hanging. The importance of inter-laboratory collaboration in extending this project by adding other available filmed hangings is discussed and the importance of a Working Group of Human Asphyxia (WGHA) is further emphasized.

Asphyxia, Hanging, Forensic Pathology

G26 The Methods of Committing and Alcohol Intoxication of Suicides in the Southwestern Croatia From 1996 to 2005

Alan Bosnar, MD, PhD, Valter Stemberga, MD, Miran Coklo, MD, and Sanja Dobi Babic, BSc, Department of Forensic Medicine, Rijeka University School of Medicine, B. Branchetta 20, Rijeka, 51000, Croatia; and Emina Grgurevic, MD, Public Health Institute of Primorsko-Goranska County, Kresimirova 52a, Rijeka, 51000, Croatia*

After attending this presentation, attendees will understand the relationship between alcohol intoxication and the choice of suicide method in the Southwestern Croatia from 1996 to 2005.

This presentation will impact the forensic community and/or humanity by through the contribution to a better understanding of the relationship between alcohol intoxication and the choice of suicide method, and by pointing towards efficiency of specific suicide prevention measures in specific methods of committing suicide.

This study was undertaken to determine if the level of alcohol intoxication and the choice of specific methods of committing suicide are related.

Suicides in the Southwestern Croatia in a ten year period, especially regarding the method of committing and alcohol intoxication, were analyzed. The examined region has an area of 7,993 km² with the population of 322,964, mostly living in the city of Rijeka, as a regional center.

In the examined period, 512 suicides were recorded, with 367 male and 154 female victims. The average age of male victims was 50.81 years, while female victims were older with the average age of 56.02 years. Ten various methods of committing suicide were recorded, with hanging as the most frequent (34%), followed by jumping from height (17%), firearms (15%), poisoning (14%), drowning (10%), jumping under/in front of a train (4%), explosive devices (4%), cutting/stabbing (1.2%), electrocution (0.4%) and self-immolation (0.4%). The average blood alcohol concentration at the moment of suicide was 0.68 g/kg with male, and 0.29 g/kg with female victims. The highest blood alcohol levels at the moment of suicide were recorded with suicides by explosive device (with the average blood alcohol concentration of 1.71 g/kg), while the lowest concentrations were recorded with female hanging suicides (with the average blood alcohol concentration of 0.0153 g/kg) and male cutting/stabbing suicides (with the average blood alcohol concentration of 0.103 g/kg).

This study suggests that the alcohol consumption before committing suicide is more significant in cases of suicide with an explosive device than in the other methods of suicide. This especially drastic method of suicide was rare in Croatia in a period prior to the Croatian Independence War (1991-1995), but its incidence significantly increased during the war and in a post-war period. These victims were not chronic alcoholics, but they consumed excessive alcohol as a result of psychiatric disorders as a consequence of war stress they suffered. This study showed that increased alcohol consumption in Croatia is more closely associated with certain methods of suicide over other methods.

Suicide, Alcohol, Croatia

G27 Suicide by Self Immolation in Cook County, Illinois, USA

Ponni Arunkumar, MD, J. Scott Denton, MD, and Edmund R. Donoghue, MD, Cook County Medical Examiners Office, 2121 West Harrison Street, Chicago, IL 60612*

After attending this presentation, attendees will learn of the prevalence of suicide by self-immolation and conditions leading to self-immolation.

This presentation will impact the forensic community and/or humanity by generating awareness of death by self-immolation, discuss, and describe the predisposing factors for this rare cause of death.

Suicide by self-immolation is extremely rare in the United States. This study aims to describe and determine the prevalence of such deaths in Cook County, Illinois, with an ethnically diverse population of 5.5 million people, which includes the city of Chicago and its neighboring suburbs. A thirteen year retrospective study from 1993 to 2005 was conducted to determine whether there were any common factors that lead to death by self-immolation. Computerized records of the Office of the Medical Examiner of Cook County were searched and reviewed for causes of death from self-immolation. The review identified 33 cases from 1993 to 2005 of such deaths. Seven cases were excluded from the study as one was a homicide, four were accident, and two were undetermined.

The age, sex, mental illness history, location of event, yearly incidence, use of accelerant, and presence of witnesses were studied.

Of the 33 cases, 23 were male and ten were female. The male: female ratio was 2.3:1. The ages ranged from 16 to 91 years old. The average age was 38.2 years. Most of the cases were in the 30-39 year age group with the following distribution: three cases (9.1%) were 11-19 years; eight cases (24.2%) were 20-29 years; nine cases (27.3%) were 30-39 years; three cases (9.1%) were 40-49 years; eight cases (24.2%) were 50-59 years; one case (3.0%) was 60-69 years; one case (3.0%) was 90-99 years. Of the 33 cases, 22 were white; ten were black, and one Asian.

Carbon monoxide determination was done in seventeen out of 33 cases. The carbon monoxide level ranged from negative to 45%. The average blood carbon monoxide level was 11.4%. Twenty-two cases received medical treatment.

An accelerant was used in 27 cases (81.84%). Gasoline was the most frequently used accelerant. It was used in 21 cases (63.6%). Charcoal lighter fluid was used in two cases. Acetone in nail polish remover was used in one case. An unknown accelerant was used in four cases.

The majority of self-immolation cases occurred at home, with nine cases. Three cases occurred in the garage adjacent to the home, one case in the front lawn of the home, two cases in the driveway of the home, two cases in the backyard of the home, two cases in a forest preserve, two cases in a parking lot, two cases in an alley, two cases near or on railroad tracks, two cases on a street, and one case each in a church, a college, a grassy area near major toll roads, and a shop.

Nine out of the 33 self-immolation cases were witnessed. Six of the cases had attempted suicide before. One had a prior attempt of self-immolation. Ten subjects had talked previously about suicide. In only five cases, a suicide note was left.

Twenty-seven cases (81.8%) had a history of mental illness, mostly depression. A history of depression was seen in seventeen cases (51.5%).

In ten cases, the cause of death was thermal burns due to self-immolation. Seven cases were determined as thermal burns due to house fire or fire. Four cases were determined as thermal burns due to gasoline fire. Three cases were closed as thermal burns and two cases as simply self-immolation. In two cases, the cause of death was carbon monoxide intoxication due to clothing fire. One case was closed as inhalation of smoke and soot due to house fire. One case each was closed as thermal injury, inhalation injury due to self-immolation, sepsis due to self-immolation, and multisystem organ failure due to thermal burns due to motor vehicle fire.

The study confirms that suicide by self-immolation is extremely rare in Cook County, Illinois, USA with an overall yearly average of 2.54 cases (0.05%). The majority of cases were male, white, with a history of mental illness, and immolated themselves at home.

Forensic Science, Self-Immolation, Suicide

G28 Seasonal Incidence of Suicides in Crete Island: A Five Year Study

Marianna Kalyva, MD, University of Crete, Department of Forensic Sciences, Medical School, Heraklion, 71110, Greece; Vasilios Stoukas, Telamonos 25, Anthoupoli, Peristeri, Athens 12135, Greece; and Anna Mavroforou, PhD, Elena F. Kranioti, MD, Panagiotis Mylonakis, MD, Antonios Papadomanolakis, MD, and Manolis Michalodimirakis, MD, JD, University of Crete, Medical School, Department of Forensic Sciences, Heraklion, 71110, Greece*

After attending this presentation, attendees will learn information concerning seasonal peaks of the suicide rates, as well as the reasons for this distribution in Mediterranean countries.

This presentation will impact the forensic community and/or humanity by increasing understanding of the suicide incidence during all year round in a country with many special factors (religion, weather conditions, people's attitude, Mediterranean temperament etc.).

Suicide is defined as the intentional act of self-destruction committed by someone who knows what he or she is doing, and who is aware of the probable consequences of his or her action. The epidemiology of the suicide phenomenon is always of major interest in contemporary forensic science. Studies have shown that suicide in some countries constitutes the third, or even the second most common cause of death for persons aged between 15 and 24 years, including accidents and homicides.

In order to study this phenomenon on the island of Crete, a retrospective analysis of all suicide cases for the period 1999 to 2003 was conducted, based on the archive files of the Department of Forensic Sciences (Medical School, University of Crete, Greece), which serves the entire region. Crete is an island (the southernmost island in Europe) with a population of about 750,000 inhabitants with millions of tourists annually.

The parameters chosen were the personal data of the subjects (age, sex, and nationality), the information concerning time and location where death occurred (date and exact time of the incident, area, and exact location), and the cause of death. In a total of 183 cases, 80.0% of them involved men and 20.0% women. One hundred seventy-two cases concerned persons of Greek nationality (94.0%) and the rest concerned foreigners. Thirty-six incidents (19.7%) occurred in 1999, 51 (27.9%) in 2000, 30 (16.4%) in 2001, 30 (16.4%) in 2002 and 36 (19.7%) in 2003.

Hanging prevailed as the main cause of death (41.0%), followed by chemical substance overdose (drugs and pesticides, 26.8%), and firearm injuries (gunshot and shotgun wounds, 21.2%). The age specific suicide rates per year were 20.0%, 16.4%, 13.1%, 15.3%, 12.0%, 12.6%, and 7.7% for 21-30, 31-40, 41-50, 51-60, 61-70, 71-80, and 81-90 age groups respectively. Four persons were of undetermined age. Seventy-one out of 183 (39.0%) cases occurred at the region of Heraklion, which corresponds with the population distribution of Crete.

The bimodal seasonal peak in the suicide rate observed in this study was in agreement with several other reports, indicating that suicide follows a seasonal pattern with a dominant peak during the spring or early summer (months of maximum day light, 14.2% and 12.0% stand for June and May respectively) and a lesser peak in the autumn. The spring peak in the suicide rate has been typically observed in Mediterranean countries. It has also been reported that agricultural populations have a longer spring peak, while industrial populations have a shorter one. This should be considered as a further explanation for the extended spring peak observed, since the suicide incidence was higher in rural areas, which were represented by 61.2%.

The suicide incidence in Crete (3.9 per 100,000 inhabitants) seems to be lower than the reported average in Greece (7.1 per 100,000 inhabitants), but higher compared to other Greek geographical regions, e.g., a suicide incidence rate of about 2.7 stands for Epirus, at the north-western coast of Greece.

Suicide, Seasonal incidence, Crete Island

G29 Suicidal Electrocution in Australia

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The goal of this presentation is to describe a series of electrocution suicides in Australia.

This presentation will impact the forensic community and/or humanity by providing details of the typical electrical suicide death scene, autopsy features, and some specific problems associated with suicidal electrocution.

Introduction: While suicide is a worldwide phenomenon, the method that is used frequently has a geographic correlation. For instance, firearm suicides make up 50% of all suicides in the USA, while intentional poisoning with agricultural pesticides is used in up to 80% of cases in some Third World countries. While electrocution is not the most common form of suicide in Australia, compared to most parts of the world it appears to be a relatively frequent mechanism of suicide that warrants further study.

Materials and methods: This retrospective study investigates the trend of suicide by electrocution in the period from 1996 to 2005 examined at the Department of Forensic Medicine, Glebe, Sydney. Reviewed were the common autopsy, histology, and death scene characteristics of individuals who commit suicide via electrocution. A total of 25,675 deaths were investigated at between 1996 and 2005, with definite or probable suicide as the manner of death in 2029 cases. Suicidal electrocution cases were obtained by searching the Department of forensic medicine autopsy text database. All cases in this study had a full autopsy, including toxicology and histology, and a detailed death scene investigation by criminalists and electricians had been performed.

Results: There were 25 cases of definite suicidal electrocution (mean 2.5 cases/annum, 1.2% of all completed suicides), and a further three cases of possible suicidal electrocution in the time period. The latter three cases were not analyzed further. Eighty-one percent of decedents were male, and the mean age was 57 years (range 22 to 90 years). At least 40% of decedents were either currently working or had worked as electricians. Psychological comorbidities, predominantly depression, were observed in 73% of cases.

In 20 of the 25 cases, the mechanism of electrocution was by attachment to a live main electrical power point using electrical flex. The flex was typically tied around the wrists, causing a lethal current to pass through the body. Deep circumferential electrical burn marks on the wrists or other extremities were typical, although there were three cases where the electrical flex had been placed elsewhere (chest or mouth). The remaining five cases had electrocuted themselves by dropping an electrical appliance in the bath. There were histological findings consistent with electrocution in one of these cases. Two showed no signs of electrocution despite the body being found immersed in water with an appliance active or recently turned off, and two others were too badly decomposed for any further assessment.

Toxicology was positive in 17 (68%) cases. These included a single drug in 14 (56%) cases, with alcohol and benzodiazepine use predominating (5 and four cases respectively) Autopsy revealed the presence of significant organic disease in 17 cases, with nine of these presenting with at least two separate pathological processes. Grossly, pulmonary congestion or edema was found in 12 cases. Histologically, morphology consistent with electrocution was found in 11 cases.

In 78% of cases, the mains circuit in the premises was still live, as was the electrical outlet used to cause electrocution. Timers had been used in eight cases, but the remaining 17 bodies were “live” on arrival of witnesses or electricity personnel. In at least one case it was reported that witnesses touched the electrically active body. Notes from the deceased warning of potential electrical hazard from touching the body were found in at least five of the cases. Safety mechanisms were not tripped in any of the cases, and were only tampered with in one case.

Discussion: While suicide by electrocution is typically described as the activation of electrical appliances while immersed in a body of water, cases in Sydney appears to have a high proportion of individuals who attach themselves to power points via exposed wires. In the majority of cases in this study the body was “live” at the time of discovery, presenting a life-threatening risk to initial responders to the death. Investigators and emergency workers should remain vigilant upon discovery of electrical suicides, due to the fact that most bodies remain electrically active long after death.

Electrocution, Suicide, Death Scene Hazards

G30 Open Fractures in Pedestrians Mimicking Gunshot Wounds

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After attending this presentation, attendees will understand the similarities and differences in the appearance of pedestrian injuries and gunshot wounds and the implications of non-forensic trained health care professionals confusing these types of injuries on initial inspection.

This presentation will impact the forensic community and/or humanity by emphasizing the need for continuing education and a close working relationship between medical examiner/coroner’s offices and health care professionals.

In February and April 2006, autopsies were performed on two pedestrians that were thought to have sustained gunshot wounds. While it was clear that the individuals had been struck by a motor vehicle, there was concern in both instances based on initial external examination at the scene by emergency personnel and at the hospital emergency department, that they had sustained gunshot wounds prior to being struck.

The first case was a 27-year-old male who was struck by a Chrysler 300 as he ran across the intersection of a local street. Information obtained from paramedics following a preliminary external examination at the scene was that the individual sustained a gunshot wound to the right thigh prior to being struck. An investigation was begun by police into the probable shooting. At autopsy, there was an open right femur fracture with an associated ½” x 5/8” irregular laceration with a surrounding irregular, contiguous abrasion located on the inner right thigh. In addition, there was a curvilinear, 3” x 4” laceration on the lateral thigh with associated extension lacerations, abrasions, and protrusion of the quadriceps muscle. Postmortem radiographs and dissection of the thigh showed no beveling and no bullet fragments or distinct wound path. Thus, the findings were not consistent with a gunshot wound. The second case was a 25-year-old female who was struck by a Nissan Maxima as she crossed a busy expressway at approximately 6:00 a.m. She was taken to the nearest hospital, where physicians interpreted injuries of the left eyebrow and right temporal region as a possible through and through gunshot wound. Because of suspicion of a gunshot wound, her hands were bagged for preservation of evidence. A homicide investigation was begun. At autopsy, a 3” curvilinear abrasion and adjacent 1” laceration with skin avulsion was present on the right temple and a ½” laceration with a contiguous curvilinear abrasion was present lateral to the left eyebrow. Autopsy, including radiographs showed linear and diastatic skull fractures, no beveled skull defects, no wound track, and no bullet fragments. Thus, the findings were not consistent with a gunshot wound.

Open fractures of long bones sustained as a pedestrian struck by a motor vehicle primarily mimic gunshot wound defects at the skin surface. The overlying skin surface can show a full thickness laceration produced by the blunt trauma. Some of these lacerations are roughly circular to irregular with contiguous abrasions similar to that of an atypical entrance gunshot wound with its surrounding abrasion collar. Closer external examination of these wounds shows that the edges can be re-approximated, unlike that seen in an entrance gunshot wound. In addition, internal dissection and radiography reveal typical compound fractures with distinct linear edges, no bone dust or minute bone fragments, no beveling, no wound track and no bullet fragments.

Since open fractures can mimic gunshot wounds, close inspection of the external wound and evaluation of the internal injury both by dissection and radiography are essential in determining whether the injuries were caused by a gunshot. This presentation emphasizes the need for educating health care professionals, especially first responders and emergency room staff, in injury patterns in order to prevent an unnecessary homicide investigation.

Gunshot Wound, Pedestrian, Laceration

G31 Homicide in a Surgical Intensive Care Unit

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The goals of this presentation will be to increase the forensic community's awareness of the potential for potassium overdose to be intentionally administered to patients in health care facilities; to explore the problems and difficulties encountered in the medicolegal investigation of such cases; and, to devise means of preventing hyperkalemic deaths as a result of intentional overdose.

With the increasing number of frail, elderly patients with multiple medical complications, it may be tempting for health care workers who are taking care of these patients to put them "out of their misery." However logical it may sound, it is unethical and contrary to law. The criminal use of intravenous potassium salts on these victims usually will not leave any evidence to identify the cause of death or the perpetrator. Investigating these cases is very difficult because the victims have multiple problems and police departments, medical examiners, and forensic pathologists are reluctant to conduct a homicide investigation in a hospital, especially the intensive care unit. Publicizing these cases will keep the forensic community alert. This presentation will impact the forensic community and/or humanity by discussing the various means of investigating such cases.

Case Background: On January 3, 2002 at 09:30 hours, E.J.M., an 83-year old woman who lived alone, was found by police in a semi-conscious state in her home. She was taken to the emergency department of a tertiary care hospital in Winnipeg, Manitoba. She was diagnosed with a fractured left hip, renal failure, myoglobinuria, and pneumonia. She was admitted at 17:47 hours and transferred to the Surgical Intensive Care Unit (SICU). The plan was to stabilize her condition before she underwent corrective hip surgery.

The following day, at 15:45 hours, her serum electrolytes revealed a potassium level of 3.3 mmol/L. As her serum chloride level was elevated, the physician prescribed potassium acetate – to be infused at a rate of 5 mmol/hour for four hours for a total of 20 mmol. A 50 cc vial of potassium

acetate (with a concentration of 4 mmol/ml) was sent to the SICU by the pharmacy. Apparently 5 ml of the potassium acetate was drawn into a 10 cc syringe and injected into a 100 ml buretrol and topped with 95 ml of normal saline and 5% dextrose. The pump was set to run at 25 ml/hour beginning at 17:00 hours.

E.J.M. was also started on 4 ml of magnesium sulfate (2000 mmol/L) intravenously to run over two hours. At 18:40 hours, as the primary nurse was otherwise occupied, the nurse responsible for the patient in the next bed added 4 ml of magnesium sulfate to the same buretrol. This nurse noted that the buretrol contained 60 ml of fluid and the pump was running at 25 ml/hour.

At 19:30 hours a shift change occurred and a third nurse became involved with E.J.M. On taking over the patient's care, the nurse "eyeballed" the buretrol and noted it contained about 75 ml of fluid and that the fluid was infusing at a rate of 50 ml/hour. Although the patient's chart contained instructions for the pump to run at 25 ml/hour, based on the volume remaining in the buretrol (75 ml) and that it would take two hours to complete the infusion, the nurse apparently, at 20:00 hours, overwrote the order to read 50 ml/hour. Around this time it also became apparent that E.J.M.'s condition was becoming unstable. Blood was drawn at 20:30 hours and sent to the hospital laboratory for electrolyte and hemoglobin levels. At 20:38 hours, E.J.M. went into cardiac arrest. An emergency code was called and she was pronounced dead after 15 minutes of resuscitation.

At 21:13 hours, the SICU was notified by the laboratory of a critical potassium level of 7.6 mmol/L. The physician was informed of these results and immediately suspected a medication error. The buretrol was seized and sent to the hospital laboratory for analysis. A search for the used 50 cc vial of potassium acetate, however, was not successful.

The death of E.J.M. was reported to the medical examiner's office on January 4, 2002 at 22:35 hours by the physician due to the possible medication error. The medical examiner commenced an investigation that included the results of the medicolegal autopsy (concluded that hyperkalemia was the cause of death), as well as the findings from the internal investigation done concurrently by the hospital. Following extensive meetings between the medical examiner's office, the hospital and the police; hours of interviewing physicians, nursing staff and other health care workers; numerous searches for the missing potassium acetate vial; and repeated testing on the buretrol contents, the medical examiner's office and the hospital jointly concurred that E.J.M.'s death was not an accident, but the result of an intentional act. Consequently, detectives from the Winnipeg Police Service officially took over the investigation on February 12, 2002.

Results: Repeated laboratory analyses of the buretrol contents revealed a potassium concentration ten times higher than what had been prescribed for the patient, an increased amount of chloride, and a trace amount of diphenhydramine, which had never been prescribed. It was also evident from the investigation that the pump speed had been doubled and additional fluids had been injected into the buretrol. Lastly, the used 50 cc vial of potassium acetate had never been recovered. Thus, it was reasonable to conclude that someone, probably a member of staff at the hospital, had doubled the pump speed and added potassium acetate, potassium chloride and diphenhydramine to the buretrol to intentionally cause E.J.M.'s death. Therefore, the manner of death was homicide. Despite a thorough police investigation, which included an extensive report by a Major Crimes analyst, there was insufficient evidence to lay charges against any individual or individuals involved.

Conclusion: This death clearly illustrates that administering excessive amounts of potassium can kill patients in health care facilities. However, hyperkalemia as a result of intentional overdose is next to impossible to diagnose by autopsy alone. Other, thorough investigations, including a review of the medical chart, analyses of any remaining fluids, and examination of the pump's memory system, are vital to the investigator in reaching a conclusion of intentional overdose. Following the death of E.J.M., it is now the practice in intensive care units in

Manitoba hospitals not to store potassium acetate or potassium chloride on the wards.

In February 2003, in the absence of criminal charges, the Chief Medical Examiner directed that an inquest be held into the death of E.J.M. The findings of the inquest judge were released in September 2005. The report can be accessed by visiting website: http://www.manitoba.courts.mb.ca/inquest_reports.html (Report No. 6 - E.J.M. – September 12, 2005).

Hyperkalemia, Intensive Care Unit Death, Homicide

G32 Subdural Hemorrhage, Subarachnoid Hemorrhage, and a Healing Tibia Fracture: Abuse or Complications of Leukemia?

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The goal of this presentation is to discuss the natural diseases that may mimic inflicted trauma and discuss methods of differentiating natural disease from neglect and inflicted trauma.

This presentation will impact the forensic community and/or humanity by highlighting issues related to pediatric autopsy and findings that may obscure cause and manner of death. A better understanding of ways that natural disease can mimic inflicted trauma will better enable forensic pathologists to avoid inaccurate diagnoses.

Objective: Child fatalities due to natural disease vs. abuse and/or neglect are challenging forensic autopsies.

Case Summary: A two-year-old boy was found dead in his foster care bed. He was receiving treatment with L-asparaginase and steroids for acute lymphoblastic leukemia. In the weeks prior to his death he became increasingly weak and had several falls witnessed by therapists and family members. In the days prior to his death he had marked thrombocytopenia.

Autopsy revealed acute small cerebral subdural and subarachnoid hemorrhage, and superior sagittal sinus and cerebral venous thromboses, a healing tibial compression fracture and extensive bronchopneumonia. There were no retinal or optic nerve sheath hemorrhages.

Discussion: Although subdural and subarachnoid hemorrhages in children are suggestive of inflicted injury, correlation of the medical history with autopsy findings in this case indicated that the neuropathologic findings were likely a result of minor trauma associated with underlying leukemia and treatment effects. L- asparaginase has been associated with abnormal blood clotting. Careful review of a decedent's medical history and correlation with autopsy findings is crucial to distinguish inflicted trauma from accidental trauma, and from natural disease processes that mimic trauma. The cause of death in this case was certified as complications of acute lymphoblastic leukemia and the manner of death was certified as natural.

Thrombosis, Neuropathology, Pediatric

G33 An Exceptional Case of Death Due to Lesions of Water Nozzle

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The goal of this presentation is to describe an exceptional case of mortal lesions due to water nozzle, a professional tool used to wash solid surfaces.

This presentation will impact the forensic community and/or humanity by describing unusual high pressure water injuries.

A 28-year-old young worker at a navy yard, died while he was trying to clean the hold ports of a ship moored at wharf of Arsenale S. Marco in Trieste (Italy).

During the investigation, the remains of the man was found laying face down on the floor of a little mobile platform raised several meters from the ground, where he was working alone.

Close to the body there was the water nozzle with the switch in the off position. There was a wide tear in the overall she was wearing and "homogenized" organic tissues were found on the platform. Skeletal elements of the remains were exposed where soft tissue had been avulsed. The postmortem examination showed skin abrasions on the right half of the face with a fracture of the skull, wide and deep soft tissue injuries of the right upper limb with areas of complete soft tissue avulsion. The soft tissue of the right side of the chest was largely absent and perforated with laceration of the lung and heart. Technical testing of the tool by an engineer showed the equipment for water cleaning was working properly, providing of water with a pressure of about 500 bars by an auto-turning nozzle. However, the safety devices had been altered. Unaltered, the jet of water should be stopped automatically if the water release and safety buttons (the last one has to be activated by the other hand) are not activated at the same time.

The scene investigation, with particular reference to the remains position, and the water nozzle found close to the body, the nature of the injuries, the negative toxicology testing, along with the technical findings about the functioning of the tool and its altered safety devices provided a clear sequence of events that led to this death. This accidental death was caused by the inappropriate use of a water cleaning device.

Water Nozzle, Crime Scene Investigation, High Pressure Water Injuries

G34 Hanging Deaths in Ontario: Retrospective Analysis of 755 Cases

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After attending this presentation, attendees will gain an appreciation of the demographics and pathology of hanging deaths in Ontario. The findings will be compared to the other series and discussed with regards to influencing factors and quality assurance standards.

This presentation will impact the forensic community and/or humanity by emphasizing the importance of documenting neck injuries in

hanging deaths, and will discuss factors influencing their frequency. It will address quality assurance issues, such as an importance of recording of pertinent negatives, use of standardized autopsy reports and dissection protocols, and utilization of additional postmortem techniques.

The frequency of neck injuries in deaths by hanging is controversial. In the literature, the range is wide, varying from 0 to 76.6% for hyoid and laryngeal fractures. Multiple factors account for this variation. Complete neck examination and accurate recording of not only positive but also negative findings are important.

This study is a retrospective analysis of deaths by hanging that happened in Ontario during a two-year period (January 1998 to December 1999). The main goal of the study was to determine the frequency of different hanging-related neck injuries. Fractures of the neck structures and soft tissue injuries were studied. Secondly, factors recognized as important in the incidence of neck fractures, such as age, sex, and weight of the deceased were evaluated. The third goal was to determine whether the frequency of hyoid/laryngeal injuries varied depending on autopsy location, i.e., forensic pathology unit, teaching hospital, or community hospital.

A total of 755 cases were available for evaluation of which 632 had a complete autopsy and 68 were limited to external examination only. In 55 cases, no postmortem examination was conducted. The largest category was suicidal hanging, at 737 cases (97.6%). Nine cases (1.2%) were accidents and two cases (0.3%) were homicides. In seven (0.9%) cases the manner of death was not determined. The mean age of the deceased was 40.58 years (the youngest victim was two and the oldest 94 years old), and there was a male predominance (82.6%). The following represents a breakdown, by location, of the cases that were examined: 240 (34.3%) in forensic facilities (of which 72.9% were complete autopsies and 27.1% were external examinations); 48 (6.9%) in teaching hospitals (of which all were complete autopsies), and 412 (58.9%) in community hospitals (of which only three were limited to external examination).

Of the 632 cases that had complete autopsies, the most common hanging related neck injuries were those of soft tissue. The latter were quite variable in severity, ranging from minute soft tissue hemorrhages to complete transection of the neck structures. Soft tissue injuries not associated with skeletal trauma were reported in 59 cases (9.3%). Associated fractures of the hyoid bone and/or laryngeal cartilages were present in 46 cases (7.3%) with the most common being hyoid fractures (30 cases). Less common were fractures of thyroid cartilage alone (10 cases), combination of hyoid and thyroid cartilage fractures (3 cases), and cricoid cartilage (3 cases). Seven cases of cervical spine injuries (fractures or dislocations) were documented.

A higher incidence of neck fractures occurred among men. There was a tendency for the number of fractures to increase with increasing age and weight/BMI of the deceased.

The frequencies of hyoid/laryngeal fractures distributed over forensic, teaching, and community facilities were as follows: 7.4%, 16.7% and 6.1%, respectively. The frequency of fractures reported in specialized forensic facilities reached 10.6% if the Forensic Pathology Unit in Toronto was excluded from the analysis. The lower frequency of fractures (2.8%) registered in this unit could be explained by different demographics of cases that underwent complete postmortem examination, specifically due to a higher proportion of complete autopsies performed on female and younger individuals. Higher frequency of fractures correlated with a higher percentage of cases in which there was accurate reporting, i.e., definite comments were made upon presence or absence of specific injuries and their site.

Hanging, Neck Injuries, Pathology

G35 Maternity and Paternity Testing of a Discarded Dead Neonate Involving a Young Girl and Her Father

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Upon completion of this presentation, participants will know how to gather evidence when the case involves a discarded dead neonate using DNA identification. In the presented case, the infant's mother was 16 years old and the infant's father was also the infant's mother's father. This is a rare paternity testing case. Sixteen Y-plex chromosomal STR testing was used to analyze the relationship of the girl's father and the infant.

This presentation will impact the forensic community and/or humanity by showing that Y-Plex STR is a very useful genetic maker for forensic practice.

A male neonate was found dead in a paper box, with the umbilical cord coarsely amputated. Next to the body there were several bloodstains on a pair of sandals marked with the name of a family living near the scene. A 16-year-old girl with the same family name was suspected as the neonate's mother, as her house was near the scene and blood was found in the toilette of her home. The girl's father and mother were divorced years ago, and her father was remarried to another woman. In order to obtain evidence to determine whether the infant was the girl's son and to establish the identity of the infant's father, DNA was extracted from the oral epithelium of the girl and her father. Blood taken at autopsy provided the source of DNA from the infant. Fifteen autosomal STR loci plus the amelogenin locus were investigated using DNA samples of the girl, her father, and the infant. To investigate the relationship between the infant and the girl's father, sixteen Y chromosomal STR loci were analyzed using DNA samples from the girl's father and the infant. The probabilities of maternity and paternity were 0.9999999 and 0.9999999, respectively, for all fifteen autosomal STR loci analyzed. Furthermore, the sixteen Y chromosomal STR loci were an exact match between the dead infant and the girl's father. These results conclusively proved that the 16-year-old girl and her father were the biological parents of the discarded dead neonate.

Discarded Dead Neonate, Maternity and Paternity Testing, STR

G36 Undetected Polyglandular Autoimmune Syndrome Type II (Schmidt Syndrome) as a Cause of Sudden Death

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The goals of this presentation are to discuss the clinical features and disease association characteristics of the Polyglandular Autoimmune Syndrome Type II, and to increase the recognition of the morbidity and mortality arising from polyglandular autoimmune disorders.

This presentation will impact the forensic community and/or humanity by demonstrating how polyglandular autoimmune (PGA) syndromes are associated with a diversity of related diseases. Diabetes mellitus Type I is a common manifestation of PGA Types II and III. Less

frequently observed is Addisonian crisis arising from co-occurring thyroiditis and adrenalitis in the absence of pancreatic involvement and resulting in sudden, unexpected death. The premorbid clinical and laboratory manifestations of this disorder can be subtle and non-specific, yet are critical benchmarks to be recognized in order to avoid a potentially lethal outcome.

Immunologic syndromes impacting multiple endocrine organs and giving rise to other nonendocrine immune disorders are a rare cause of sudden, unexpected death. Endocrine deficiency due to Polyglandular Autoimmune Syndrome can be brought on by infection, infarction, or tumor that results in the destruction of all or a large part of an endocrine gland. In most cases, however, the activity of an endocrine gland is depressed as a result of an autoimmune reaction that produces inflammation, lymphocytic infiltration, and partial or complete destruction of the gland. There are three patterns of Polyglandular Autoimmune (PGA) Syndrome, referred to as types I, II, and III. PGA Type I usually occurs in childhood and is characterized by hyperparathyroidism (79% of cases), followed by adrenal cortical failure (72%). Diabetes mellitus Type I seldom occurs. PGA Type II generally occurs in adults and always involves the adrenal cortex and frequently the thyroid gland (Schmidt syndrome) and the pancreatic islets. Type II is the most common of the syndromes and is characterized by the occurrence of autoimmune Addison's disease in combination with thyroid autoimmune diseases and/or diabetes mellitus Type I. The most frequent clinical association is between Addison's disease and Hashimoto's thyroiditis, while the least frequent clinical combination is Addison's disease, Graves' disease, and diabetes mellitus Type I. PGA Type III occurs in adults and does not involve the adrenal cortex, but includes at least two of the following: thyroid deficiency, diabetes mellitus, pernicious anemia, vitiligo, and alopecia.

Following the sudden death of a 38-year-old Caucasian female an autopsy revealed findings consistent with the diagnosis of Schmidt syndrome, or Polyglandular Autoimmune Syndrome Type II. While diabetes mellitus Type I was not diagnosed, as is the case in 50% of PGA Type II presentations, her past medical history included an ill-defined thyroid disorder and recent premorbid history of listlessness to extreme fatigue and non-specific somatic complaints. Her healthcare professional failed to make the correct premortem diagnosis. The differential diagnosis of this disorder is addressed, as is a brief discussion of the polyglandular autoimmune syndromes, with particular emphasis on the etiology, epidemiology, morbidity, and mortality associated with Polyglandular Autoimmune Syndrome Type II.

Autoimmune, Polyglandular, Endocrine

G37 Suicide by Ingestion of Carbamate Insecticide: Case Report and Regional Variations

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After attending this presentation, attendees will understand how insecticide ingestion is a significant method for suicide both globally and nationally. Attendees will also understand the possible threats to first responders and healthcare personnel attending to victims of insecticide self-ingestion.

This presentation will impact the forensic community and/or humanity by attempting to further increase understanding of suicide patterns, focusing upon a means not commonly observed in the United States but frequently employed in select regions of Asia. In addition to

addressing mechanisms of actions and common routes of administration, health risks that such ingestions present to responding personnel are also presented. Based upon commonly understood risk factors leading to insecticide-related suicide from certain areas of Asia, potential parallels to certain regions of the United States are reviewed. Additional issues explored include assessing the predisposition to insecticide-related suicide based on geography, agricultural intensity, accessibility to such poisoning agent(s), and relative lack of access to medical centers capable of rendering rapid treatment and antidote(s).

Propoxur (Baygon) is a potent carbamate insecticide used to control cockroaches, flies, mosquitoes, and lawn and turf insects. It is also a poison used to complete suicide. Insecticide intoxication is a significant method of suicide in some areas of the world. A 55-year-old black male was found unresponsive in his garage with a glass of Propoxur adjacent to him. Upon transport to a suburban Philadelphia hospital emergency department, fumes from the insecticide emanated from the victim's body, sickening 29 hospital workers and 12 hospital patients. As a safety precaution, the hospital was quarantined and its employees decontaminated. It is imperative for physicians, emergency medical service personnel, and investigators to be aware of the risks and detrimental consequences involving deaths associated with insecticide ingestion. While proper handling of patients is crucial, healthcare personnel should be aware of the public health risks created by individuals who ingest select poisons. Propoxur's mechanism of action relies upon the reversible carbamylation of acetylcholinesterase, resulting in a subsequent accumulation of acetylcholine in myoneuronal junctions (i.e., both in nicotinic and muscarinic systems). The modes of absorption include inhalation, ingestion, and dermal penetration, and the pertinent signs and symptoms include diaphoresis, urination, bradycardia, seizures, and bronchospasm. Insecticide ingestion as a means of suicide is stratified by two principal variables, these being availability of the agent(s) utilized and the related variable of agricultural intensity within the region of the world studied. In rural, agricultural regions of Sri Lanka and China, a high incidence of self-poisoning deaths have been attributed to harsh living conditions, stressful situations, accessibility to the poisoning agent(s), and relative lack of access to medical centers capable of rendering rapid treatment and an antidote(s). Access to lethal means is one principal variable observed from suicide patterns in the United States, though the most common injury associated with completed suicides in this country derives from firearms. The premise proposed is that those regions of the United States which parallel most closely those conditions predisposing to suicidality as observed in Sri Lanka and rural China should exhibit higher insecticide ingestion-related suicide rates in comparison to other areas of the country.

Insecticide, Suicide, Healthcare Worker Risks

G38 Chemical Asphyxia and Bondage: Autoerotic Fatality Induced by Chloroform Inhalation

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It is important to acknowledge variations from characteristic autoerotic asphyxial death practices. The use of chemical inhalation, more specifically chloroform, as a means to create a euphoric autoerotic state has rarely been discussed in past literature. After attending this presentation, attendees will learn how autoerotic asphyxia is also rarely observed in those older than the sixth decade.

It is well recognized in contemporary literature that autoerotic asphyxial deaths are most commonly observed among Caucasian males in the third to fourth decade of life. However, there are cases that are distinct from the common pattern of age demographics and the means of attaining

a hypoxic state. This presentation will impact the forensic community and/or humanity by demonstrating how it is imperative to acknowledge that significant variations from characteristic autoerotic asphyxial practices do occur. The possibility of autoerotic asphyxial death should be entertained in the aged population when corroborated by appropriate scene and evidentiary information.

Autoerotic asphyxia is a paraphilia in which a hypoxic state is induced in order to enhance orgasm during sexual activity. The medical examiner becomes involved in those situations in which the hypoxic state becomes irreversible and results in the death of the practitioner. While this practice is observed most commonly in Caucasian males whose ages range from the third through fourth decades, deviation from these demographic variables do occasionally occur. Autoerotic asphyxiation through the use of a ligature about the neck, with escape mechanism, is the most common means of this practice. More atypical approaches to reach a euphoric state through oxygen deprivation include rebreathing via the use of a plastic bag, positional asphyxia through thoracic compression, submersion, and chemical inhalation. Chemicals most frequently cited as hypoxic agents in available literature documenting autoerotic practices include propane, butane, ether, aerosol glue, tetrachloroethylene, 1-1-1 trichloroethane, and ketamine. Documentation of chloroform use in autoerotic asphyxial practice is distinctly uncommon.

A 67-year-old Caucasian male was discovered in bed and multiply bound within his suburban Philadelphia, PA residence. The decedent was discovered wearing a black rubber gas mask, with a bottle of chloroform situated on an end table adjacent to his head. A postmortem interval of at least two to three days had transpired from the time of death until the time of discovery. Toxicological assessment demonstrated the presence of chloroform in the blood, liver, brain, and lung of the decedent, consistent with inhalation of this agent in an effort to induce a hypoxic, reversible state. Scene investigation disclosed evidence supportive of multiple paraphilias engaged in by the decedent, including leather and black rubber fetishism and masochistic acts, including earplugs and genital entrapment. Numerous enema bags were distributed throughout portions of the otherwise fastidious residence, suggesting klismaphilia. While deaths arising from the performance of autoerotic asphyxia characteristically involve young Caucasian males through the use of a neck ligature, it is important to recognize significant variation from this general pattern. It is likewise imperative to consider the possibility of additional participants and criminal activity when confronted with such scenarios.

Chloroform, Autoerotic, Paraphilia

G39 Hemophagocytic Lymphohistiocytosis: A Case Report and Review of the Literature

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The goal of this presentation is to discuss a case of a rare hematologic syndrome (Hemophagocytic Lymphohistiocytosis), and a literature review. New data has shown, that in the infection associated form of hemophagocytic syndrome, a selective loss of cytotoxic function in antigen presentation to T cells, creates an imbalance in the immune system, and promotes abnormal/excessive production of T cell derived cytokines, such as Interferon gamma (IFN γ), which is quite toxic, and leads to the characteristic clinical and histopathologic features of HLH. This is a rare entity, yet important, because it has a primary and secondary form, which may occur in the young, and in individuals with no known underlying immune deficiency/lymphoproliferative disorder.

This presentation will impact the forensic community and/or humanity by identifying and discussing the different forms of this syndrome, i.e., primary and secondary; its clinical, laboratory and histopathologic findings and its unusual cause of death in those individuals

affected by this syndrome. The entity is a hematologic and anatomic/forensic curiosity, with remarkable gross and microscopic findings.

Statement of Methods: This poster will present a case report and literature review of: Sporadic Hemophagocytic Syndrome, and its clinical, laboratory, and histopathologic manifestations, with a focus on its sometimes innocuous presentation as a viral illness, leading to rapid (within 14 days) death in both young and older patients.

Abstract: The focus of this case report is patient EC, a 77-year-old male, who was transferred from an outside hospital to the institution with confusion, ataxia, pancytopenia, diffuse lymphadenopathy/ splenomegaly, and a flu-like illness with temperature spikes to 103° F. His past medical history included CAD s/p MI, dermoid tumors, and hypercholesterolemia. He underwent a cervical lymph node biopsy during admission, which demonstrated a non-clonal proliferation of T-cells with Epstein-Barr virus positivity (by in-situ hybridization, consistent with mononucleosis). EC was treated with steroids without improvement of his lymphadenopathy. Labs during admission: WBC **2.6**; Hgb **9.5**; Plt **34** Neut: 40.9%; Lymphs: **51.5** %; Eos: 3.6% Absolute Neutrophil Count: **5650**. Serology tests showed EBV IgG positive/Ig negative, CMV IgG positive/IgM negative, RPR negative, HIV negative, toxoplasmosis negative. For his entire hospital admission, he had no bacterial growth in his blood cultures, but did have *S. aureus* positive respiratory cultures.

Within two weeks of admission, EC suffered a non-Q wave myocardial infarction, with an echocardiogram study showing an EF of 25 – 30%. Although the work up of his hematologic aberrancies continued, the patient's medical status deteriorated following his MI.

The patient developed hypoxic respiratory failure and cardiogenic shock, and expired on 15 days after admission.

At autopsy, the body was that of a cachectic older male with marked generalized lymphadenopathy. Histologic findings included a newly diagnosed pleomorphic high-grade large B-cell lymphoma, which showed EBV positivity and systemic hemophagocytic lymphohistiocytosis. The presence of the stain LMP-1 in most of the lymphoma cells is consistent with an EBV-driven disorder. There was also evidence of a remote myocardial infarct and pleural fibrosis.

Hemophagocytic lymphohistiocytosis (HLH) is a life-threatening condition characterized by uncontrolled hyper-inflammation on the basis of various inherited or acquired immune deficiencies. It is also characterized by clinical, laboratory and histologic findings. The clinical symptoms/signs include: fever, severe constitutional symptoms, lymphadenopathy, hepatosplenomegaly, icterus/jaundice, neurologic symptoms (seizures, CN palsies, encephalitis, meningismus) and rash (maculopapular/nodular eruptions). Laboratory criteria include: pancytopenia (cytopenia in at least two cell lineages), hypertriglyceridemia, high ferritin, transaminases, bilirubin, and LDH. Also, hypofibrinogenemia, high levels of the α chain of the soluble IL-2 receptor and impaired function of Natural Killer Cells and cytotoxic T cells. Histopathologic findings are: reactive and systemic proliferation of benign histiocytes that phagocytose blood cells and their precursors in bone marrow, and or spleen. EC fulfilled the criteria for the acquired form of hemophagocytic syndrome, due either to an EBV infection, lymphoma, or a combination of both: an EBV-driven high-grade lymphoma.

Familial forms (FHLH) hemophagocytic lymphohistiocytosis is the entity where HLH is the primary and only manifestation, occurring in approximately in 1/50,000 births. FHLH is associated with immune deficiencies such as: Chédiak-Higashi Syndrome, Griscelli Syndrome, and X-linked lymphoproliferative Syndrome. Secondary (Sporadic) HLH is associated with the trigger of a benign or neoplastic disease (most patients have no known underlying immune deficiency), such in the patient, EC. Various infectious microorganisms, mostly viruses, such as EBV, but also bacteria, protozoa and fungi, induce secondary HLH. In a review article from 1996 of children with infection-associated hemophagocytic syndrome (IAHS) EBV was found to be the triggering event in 74% of cases. HLH may also occur as a complication of

rheumatologic disorders (macrophage activation syndrome), malignancies (especially T cell lymphomas), also known as Lymphoma associated Hemophagocytic Syndrome (LAHS). EBV was detected only rarely in those with B- cell lymphomas, and much more so, 80%, in patients with T/NK lymphomas. The median survival time with pts with LAHS is about 11 days.

New data about what the possible etiologies are for sporadic hemophagocytic syndrome have shown that uncontrolled secretion of cytokines may stimulate the proliferation and phagocytic activity of macrophages, and therefore cause widespread inflammation, and the severe pancytopenia seen in this entity. More specifically, a selective loss of cytotoxic function in antigen presentation to T cells, creates an imbalance in the immune system, and promotes abnormal/excessive production of T cell derived cytokines, such as Interferon gamma (IFN γ), which is quite toxic, and leads to the characteristic clinical and histopathologic features of HLH.

In conclusion, in the presented case, the clinical, laboratory, and autopsy findings demonstrate case of Secondary Hemophagocytic Lymphohistiocytosis. The disease entity has specific clinical, laboratory and histopathologic findings, and when sporadic, can present as an innocuous viral illness, as in EC's case, with fatalities occurring within two weeks of presentation, due to uncontrolled hyper-inflammation and activated macrophages/histiocytes that kill/ingest all hematopoietic elements, causing widespread pancytopenia.

Hemophagocytic Lymphohistiocytosis, Epstein Barr Virus (EBV), Interferon Gamma (IFN γ)

G40 Snake-Shot From a Handgun: An Unusual Gunshot Wound Suicide

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After attending this presentation, attendees will learn about projectiles for handguns that fire snake-shot and the use of such a projectile in this case of suicide and be able to recognize the following: How snake-shot can be fired from a handgun, how such a projectile can create an unusual entrance wound on postmortem examination, how to reconcile radiologic findings typical of a shotgun with a handgun as the weapon, and why such findings are not inconsistent with a suicide.

This presentation will impact the forensic community and/or humanity by providing useful information about unusual but not uncommon ammunition used in a suicide.

A 49-year-old man had an argument with his wife at his home. He got a revolver out of his locked gun cabinet, went out to his car, and was found dead in the car some time later with a gunshot wound. Scene investigation found the revolver in the deceased man's hand. There was no shotgun present in the house or the car. A suicide note to the son was located in the house.

Initially, the location of the gunshot wound made this suspicious for a homicide. He was shot behind the right ear. Autopsy procedures included photography, gunshot residue, X-Ray, toxicology, and visceral dissection. The X-Ray of the decedent's head showed unusually extensive fracturing of the cranium and numerous pellets in the cranial cavity.

Close examination of the gunshot wound revealed a hard contact, stellate, penetrating wound of the head, of unusual dimension for a handgun, located above and behind the right ear. A muzzle mark was difficult to distinguish because of the numerous stellate tears radiating from the entrance perforation. The parietal bone of the skull had a perforation with fouling beneath the periosteum. The right parietal and occipital lobes were perforated by multiple pellets, partially dividing the midbrain from the cerebral hemispheres. The pellets also perforated the left cerebral hemisphere, pulpifying the brain parenchyma.

These pellets on X-Ray and direct examination were consistent with snake-shot. This ammunition is most frequently used in shotguns. When it is fired from a handgun, it is typically used to kill reptiles and other thin-skinned small animals at short distances, up to approximately five yards. Handguns of many calibers including 9 mm, .357 Magnum, .38 Special, .40, .44 Special and Magnum, and .45 semi-automatic may accept small pellet-filled projectiles which contain shot of the same size as that used in a shotgun, but with a smaller load and charge.

The rounds consist of a hollow plastic projectile that contains the loose shot. If snake-shot is used in a gun without the encapsulating plastic, the lead shot may form pits in the rifling of the barrel. The cartridge moves down the barrel of the handgun and opens on leaving the muzzle; normally, the shot does not separate until after it has left the barrel. With shot of size #12, colloquially known as snake-shot, there might be as little as 1.5 to 3 ft-lb of energy in each pellet as it hits the target. While it might easily penetrate human skin at close ranges (but not contact), it would not be expected to penetrate deeper into the body than muscle tissue, and so would not be typically used in a homicide. Some experts report that the rounds are not useful for self-defense, especially against a human assailant, as the penetration is minimal and the shot diameter tiny. However, in the case of a direct hard contact gunshot wound this ammunition created a surprising amount of damage that was more than sufficient to kill.

The cause of death in this case was a hard contact gunshot wound of the head. The manner of death was suicide, based on the autopsy and scene investigation. The use of snake-shot as ammunition was unusual but just as lethal as a bullet.

Snake-Shot, Handgun, Suicide

G41 Non-Traumatic Homicide Following Assault: 16 Cases - A Review of Investigation, Pathology, Toxicology, and Judicial Outcome

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After attending this presentation, attendees will understand some principles of the classification of the manner of death as homicide when death occurs as the result of a physical altercation or a significant implicit threat in the absence of fatal traumatic injuries, by reviewing the investigation reports, the pathology reports, the toxicology reports, and the judicial outcomes of these cases.

This presentation will impact the forensic community and/or humanity by discussing how these types of cases can differ from traditional homicides which most often result from traumatic injuries and the classification problems which can arise including a review of the Davis guidelines written in 1978 and the judicial outcome differences.

Homicide is most often defined as death at the hands of another. When traumatic injuries are the cause of death, the manner of death is usually obvious and clear. However, when the traumatic injuries do not cause death and one must rely on the investigation for the manner of death, the case must be critically evaluated. If a physical altercation takes place immediately prior to death or the development of signs and symptoms such as chest pain begin during or within a short time after the assault, then temporal relationship between the assault and the death cannot be ignored and a manner of death of homicide must be considered. Likewise, if no contact between the decedent and the assailant(s) occurs, but there is a significant implicit threat to safety (Davis guidelines), one must also consider homicide, as again, the temporal relationship cannot be ignored.

Sixteen cases were reviewed from the state of Maryland from the years 1990 through 2006 where death was determined to be the direct

result of a struggle/assault or the result of a significant implied threat. All of the cases were classified as homicides on the death certificates. None had any traumatic injuries listed on the cause of death line or as contributory to the cause of death although some did have minor lacerations, contusions, and abrasions. Of the 16, three (19%) were female. Eight (50%) were African American. The ages ranged from 15 years to 89 years with a mean age of 55 years. Most of the causes of death were cardiac in nature including cardiac arrhythmias, coronary artery disease, hypertensive changes, congenital anomalies, aortic dissection, and coronary artery tunneling. In addition, one case of ruptured berry aneurysm was noted. Toxicology was negative for ethanol in 12 of the 15 cases (80%) cases and negative for illicit drugs in ten out of 13 (77%) cases in which drugs were tested. Of the positive cases, cocaine and morphine were the illicit drugs that were identified. Cocaine was detected in all three cases with morphine additionally detected in one of the three. Cocaine was listed as a contributing cause of death on the death certificate in all three cases.

In 15 of 16 cases (94%), there were physical altercations between at least two individuals. Of these, four (27%) were known to use a blunt object other than a fist such as a baseball bat (2), walking cane, or walker. In one case a blunt object (plank) was thought to have been used but was not confirmed through investigation. One individual was held at gunpoint but a physical struggle never ensued prior to loss of consciousness. In three (19%) cases no injuries, even minor, were described. The majority of cases (69%) involved individuals over 50 years of age. The remaining younger population could be further subdivided into those with congenital abnormalities and those with positive toxicology.

The judicial outcomes for these cases varied from no charges filed to full jury trials. The determination of the extent of prosecution for each case was case dependent because of their complexity and nature. In one case there was a bench trial with a conviction, subsequent appeal and retrial with a jury.

Davis Guidelines, Non-Traumatic Death, Homicide

G42 Death by Cue in the Parietal Pocket: An Unusual Injury Pattern Caused by the Use of a Blunt Object

Valerie S. Green, MD, Mary L. Anzalone, MD, Dwayne A. Wolf, MD, PhD, and Luis A. Sanchez, MD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

The goal of this presentation is to stress the importance of obtaining accurate and detailed investigative information, and keeping an open mind about the findings at autopsy. The injury pattern and the weapon may not be what you expect them to be.

This presentation will impact the forensic community and/or humanity by continuing to reiterate the need for excellence in forensic investigation and by alerting the community as to other potential uses of a seemingly harmless recreational object.

A 27-year-old man died from a penetrating injury of the head with perforation of the skull and brain by a pool cue. The decedent was involved in an altercation with another individual that began with an exchange of punches, and ended with the decedent lying on the floor with a pool cue in his head. Bystanders reported the decedent being immediately unresponsive following the altercation. Paramedics arrived and used a bolt cutter to cut the pool cue, leaving a portion remaining in the decedent's head. The decedent was then transferred to a local hospital where he remained in critical condition throughout his 8-day hospital stay.

Computed tomography of the head revealed a tubular piece of foreign material embedded into the skull with acute fractures in the left parietal bone, at the point of entry. The wound tract extended through the left parietal lobe, crossing the midline and traversing the thalami. Acute fractures were seen in the squamosal portion of the right temporal bone at

the point of exit. Associated findings include hemorrhagic foci along the wound tract, scattered foci of subarachnoid hemorrhage, acute blood throughout the lateral, third, and fourth ventricles, air within the left temporal horn and a 1 to 2 millimeter thick acute subdural hematoma along the right fronto-temporal convexity.

The decedent was operated on immediately. The retained portion of pool cue was 16.8 centimeters in length and 1.4 centimeters in diameter. The distal end of the pool cue was intact with a blood stained disrupted white collar, 2.5 centimeters from the distal end. Dried blood and strands of attached hair were present on the cue up to approximately 4 centimeters from the distal end. The proximal end was uneven and broken off. The remaining portion of the pool cue was obtained from law enforcement and consisted of a traditional wooden stick with a broken distal end that matched the removed segment.

The findings at autopsy included a surgically altered left parietal scalp defect, and discrete foci of subscalpular hemorrhage at the points of entry and exit of the object through the skull. The oval left craniotomy window had a central round metal surgical device covering a 2 centimeter round defect with inward beveling. A 2.2 centimeter, somewhat square-shaped, fractured defect with partial outward beveling was within right temporal bone.

Small round defects are in the frontal bone and dura due to the insertion of pressure monitors. Gel foam and subdural hemorrhage were in the left parietal region and associated with a 3.0 centimeter sutured round dural patch. Approximately 20 milliliters of subdural hemorrhage was present over the right cerebral convexity. A circular, punched-out, round defect involved the dura of the right temporal bone and is associated with the aforementioned temporal bone defect. The calvarium was 2 to 3 millimeters in thickness, diffusely.

The brain weighs 1300 grams. It herniated through the right temporal bone defect. A 2.0 centimeter circular defect was in the left parietal convexity, and a 1.5 centimeter defect was in the right lateral temporal lobe. The cerebral hemispheres were symmetrical with marked swelling characterized by flattened gyri and narrowed sulci. Patchy subarachnoid hemorrhage was present over cerebral convexities and at the base of the brain.

Following formalin fixation, sections through the cerebral hemispheres, cerebellum, and brainstem revealed a hemorrhagic wound track coursing through the left parietal lobe, midline structures including the thalami, and the right temporal lobe. Extensive hemorrhage and tissue destruction were associated with the wound track. Secondary hemorrhages are in the rostral brainstem.

Microscopic examination showed parenchymal hemorrhage in the brainstem, ischemic neuronal change, and hemorrhage with tissue destruction from the section of the wound track. Iron stains on the sections were negative.

Head Injury, Blunt Object, Unusual Pattern

G43 Pediatric Malignancies Presenting as Sudden Death: A Case Series

Allison S. Nixdorf-Miller, MD, Tracey S. Corey, MD, Barbara Weakley-Jones, MD, and William R. Ralston, MD, Office of the Chief Medical Examiner, 810 Barrett Avenue, Louisville, KY 40204*

After attending this presentation, attendees will learn how pediatric malignancies, though rare, may present as sudden death. Careful examination of the history and physical findings will aid in the ultimate cause of death.

This presentation will impact the forensic community and/or humanity by aiding in better understanding of pediatric malignancies in sudden death.

The goal of this presentation is to review causes of sudden death due to previously undiagnosed malignancies in the pediatric population from

1994 to 2006 at the Office of the Chief Medical Examiner in Louisville, Kentucky.

Five deaths due to malignancies in children between the ages of five months and fourteen years were identified during this time period. Two Wilm's tumors, a T-cell mediastinal acute lymphoblastic lymphoma, and two acute myeloblastic leukemias are listed as the causes of death. None of the five cases reported had a previous diagnosis of malignancy prior to death. In fact, one case (AML M5) was thought to be a victim of child abuse due to the physical findings of bilateral black eyes.

Cases 1 and 2: Unlike death in the case of Wilm's tumor due to intraperitoneal hemorrhage reported by Somers et al, the children in both of these Wilm's tumor cases of died as a result of pulmonary tumor emboli. A five-year-old girl followed closely by her family physician for mild developmental delay was participating in class activities and was thought to have fallen asleep in class. She was unarousable, and subsequently it was determined she had died. At autopsy, a 6.5 cm Wilm's tumor was found in the upper pole of the left kidney, with extensive but microscopic pulmonary tumor emboli within all lobes of the lungs. The second Wilm's tumor was found in a three-year-old boy who had a three day history of vague abdominal pain and constipation. He collapsed after being given antacids for his pain. The 8.0 cm tumor within the left kidney caused a large tumor thrombus within the inferior vena cava and a tumor embolus with occlusion of the right ventricular outflow tract and pulmonic trunk.

Case 3: A ten-year-old boy presented to his primary care doctor five times in the three months preceding his death with complaints of fever, cough, wheezing, and neck swelling. He was diagnosed at the last visit as having pneumonia with a widened mediastinum. That evening he began gasping for air, became cyanotic, and collapsed. At autopsy a 470 gm, 22.0 cm mediastinal mass completely encased the aortic arch and great vessels, trachea, anterior pericardial sac and hilum. The superior border of the mass was the thyroid gland. Immunophenotyping confirmed a T-cell mediastinal acute lymphoblastic lymphoma. In this case no other organs were involved.

Case 4: A 14-year-old girl with a three week history of headache, abdominal pain, extreme fatigue and fevers, was brought to the emergency room in full arrest. She had been seen in the ER three times in the week prior to her death with the above listed symptoms and given a clinical diagnosis of pharyngitis with a suspected etiology of infectious mononucleosis. At autopsy a large intracerebral hemorrhage was found, with petechiae in all visceral organs. In addition to massively enlarged visceral lymph nodes, leukemic infiltrates were found within the spleen, liver, heart, adrenals, and brain. Immunohistochemical stains performed on the paraffin embedded tissue confirmed the diagnosis of acute myeloblastic leukemia.

Case 5: A five-month-old boy presented to an outlying hospital with a two day history of gasping for air, bloody emesis, lethargy, and decreased urine output. He rapidly deteriorated in the emergency room, and was brought to a local hospital where he was pronounced dead. A history of abuse or neglect by the family was suspected due to severe bilateral periorbital ecchymoses, and multiple additional contusions. After his death, laboratory results revealed his white count to be 269,000. At autopsy, small bowel intussusception with resultant bowel necrosis was identified, with an extensive leukemic infiltrate. Ensuing disseminated intravascular coagulation led to petechiae and the large periorbital ecchymoses, as well as extensive subarachnoid hemorrhages. Leukemic infiltrates were found within the pericardial sac, liver, kidneys, leptomeninges, pancreas, spleen, gastrointestinal tract, and lung leading to acute pulmonary crisis. Immunophenotyping revealed an acute monocytic leukemia (M5).

These cases correlate with one recent paper in which Wilm's tumor and white cell malignancies were the most common malignancies presenting as sudden death in the pediatric age group. These findings differ from another paper, which found that tumors, malignant or benign, involving the central nervous system and heart were most common in their case series. Accidents are the most common cause of death in the pediatric

age group, with cancer being second. Leukemia is the most common malignancy in children between the ages of 0-19, followed closely by central nervous system malignancies. These constitute the two most common causes of cancer deaths in this age group. Most malignancies are diagnosed by classic signs and symptoms, failure to thrive, weight loss, fatigue, feeling poorly, and autopsies on these patients, when requested, are undertaken in the hospital setting with a known or suspected diagnosis. In the five cases presented, preceding symptoms did not lead to a timely diagnosis. Sudden death is a rare, unfortunate presentation of pediatric malignancy.

Sudden Death, Malignancy, Pediatric

G44 An Experimental Comparison of Bone Wound Ballistics of Non-Lead and Lead Bullets

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After attending this presentation, attendees will gain an understanding of how the increasingly prevalent use of non-lead bullets affects forensic examination and investigation.

This presentation will impact the forensic community and/or humanity by increasing knowledge of wound ballistics extended to the non-lead bullet trajectory through results from experimental impact biomechanics testing.

In this work a new type of small arms ammunition is evaluated to determine its capability of producing wound trauma. This new ammunition dispenses the toxic lead core of conventional bullets in favor of a non-toxic pressed tungsten and tin powder core. The testing involved firing rifle and pistol caliber tungsten tin and lead core bullets against real porcine femurs encased in ballistic gelatin. The lead bullets were used to establish a benchmark of performance for the tungsten tin bullets to be measured against. Various metrics such as penetration depth and bone fragment weight were recorded.

The specific cartridge calibers used in the testing were the 9mm x 19mm (Luger) and the 5.56mm x 45mm (5.56 NATO). The specific bullet types evaluated were the semi-jacketed soft point with a brass enclosed base. The bullet weight of the 9mm projectile was 124 grains and the bullet weight of the 5.56mm projectile was 60 grains. The ratio of tungsten powder to tin powder was set by weight at 68% W and 32% Sn for a net density nearly identical to lead. This resulted in the tungsten tin bullets being the same shape, size, and density as the lead bullets.

Ordnance gelatin powder was mixed 10% by weight according to accepted standards to replicate within 3% the penetration depth measured in living swine leg muscle as established by Fackler (1985). The gelatin was molded into a rectangular block with a rounded front face. The overall dimensions of the block were 24" long, 8" wide, and 16" high and required 36 liters of water and 4 kilograms of gelatin powder to manufacture. The bones were mounted upright approximately 4" behind the front face. The blocks were maintained at 39° F for at least eight hours prior to and during the shot. The ballistic gelatin block was mounted on a table 10' away from the muzzle of the firearm in accordance with FBI ballistic testing protocol. Three separate 0.177" BB's were fired into each ballistic gelatin block to verify acceptable block density.

Four combinations of bullet type were evaluated and three shots of each combination were made. The tungsten tin pistol bullets had a mean velocity of 1035 ft/s and a total mean penetration depth of about 14.5" with a mean distance of 9.12" beyond the bone. There were

approximately 180 grains of bone fragments generated by the W-Sn bullet impact. The lead pistol bullets had a mean velocity of 1048 ft/s and a total mean penetration depth of about 13" with a mean distance of 6.78" beyond the bone. There were approximately 73 grains of bone fragments generated by the Pb pistol bullet impact. The lead rifle bullets had a mean velocity of 2792 ft/s and a total mean penetration depth of about 6" and went a mean distance of 1.08" beyond the bone. There were approximately 287 grains of bone fragments generated by the Pb rifle bullet impact. The tungsten tin rifle bullets had a mean velocity of 2843 ft/s and a total mean penetration depth of about 16" with a mean distance of 10.33" beyond the bone. There were approximately 266 grains of bone fragments created by the W-Sn rifle bullet impact.

It was found that the performance of the W-Sn pistol bullets was closely similar to that of the Pb pistol bullets, but the W-Sn bullets created a higher mean collective weight of bone fragments than the Pb pistol bullets did. The W-Sn rifle bullets exhibited much deeper post-bone penetration depth than the Pb rifle bullets, although the mean collective bone fragment weight was approximately the same. It was concluded that there was essentially no difference between the W-Sn and Pb pistol bullets but that the W-Sn rifle bullets would create a much deeper permanent cavity than Pb rifle bullets. The mechanism of this deeper penetration depth was attributed to the resistance to fragmentation of the W-Sn bullet in hard and soft tissue.

Reference:

¹ Fackler, M.L., Malinowski, J.A.: The Wound Profile: A Visual Method for Quantifying Gunshot Wound Components. *J. Trauma*, 25 (6) : 522-529, 1985.

Bone Wound Ballistics, Non-Lead Bullet, Ballistic Gelatin

G45 Model Protocol for Forensic Medical Examination of Victims of Trafficking in Human Beings

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After attending this presentation, attendees will understand basic health issue related to trafficking in human beings (THB), in particular these related to physical trauma, sexual violence, and substance misuse. The attendees should also become familiar with advantages of early medicolegal examination of THB victims.

This presentation will impact the forensic community and/or humanity by giving arguments and advocate for necessity of medicolegal health-care for THB victims that is mostly being neglected in existing local anti-trafficking policies and intervention protocols. A positive example of Istanbul Protocol use in evaluation of torture victims would serve as an illustration of good practice in sound related field.

The presentation will discuss the experience gained through the trainings for medical and judiciary professionals in countries of Western Balkans (Serbia, Bosnia and Herzegovina, and Croatia). A protocol developed for forensic medical examination of victims of THB will be discussed in detail. It is recommended that the agenda of anti-trafficking policies needs to be redrawn to include forensic medical assessment of victims for legal purposes.

Human Trafficking, Forensic Medical Examination, Injury

G46 The Role of Postmortem Cardiac Enzymes in the Diagnosis Acute Cardiac Deaths

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After attending this presentation, attendees will have a greater understanding of biomarkers of acute myocardial injury and their role, or lack thereof, in the postmortem diagnosis of myocardial infarction. The information presented here will help guide the investigations and autopsies in cases of suspected acute cardiac deaths.

Sudden deaths due to myocardial infarction compose a large percentage of the workload of investigators, coroners, and forensic pathologists and others whose work involves death investigation. This presentation will impact the forensic community and/or humanity by aiding these workers in the approach and workup of suspected acute cardiac deaths. While biomarkers of myocardial damage may have some utility in the diagnosis of acute cardiac deaths, they should not be used exclusively to make the diagnosis. As deaths certified due to myocardial infarction occasionally incite legal battles involving employers and treating physicians, it is of the utmost importance to correctly classify these deaths and not simply rely on a single or series of biological markers. In addition, performing routine postmortem markers of myocardial damage can be costly and may consume resources that could be better utilized on other testing or equipment.

Sudden cardiac deaths due to myocardial infarction constitute a large percentage of the caseload for death investigators, coroners, and forensic pathologists. While sometimes one has a high level of suspicion of a myocardial infarction at autopsy, it is only by finding a thrombus or seeing characteristic gross or microscopic morphological changes in the myocardium that one can definitively make this diagnosis. Because of this, researchers continue to seek out a more sensitive method of determining acute myocardial damage. For years, treating clinicians have been able to measure serum levels of proteins and enzymes normally contained within the myocardium. Increased serum levels of these markers have been shown to be highly sensitive and specific for myocardial damage. The preferred markers have changed over time, but currently three of the more reliable markers include troponin (isoforms I and/or T), total creatine kinase (CK), and CK-MB a more specific isoform of CK.

Various authors have investigated the role of postmortem cardiac markers at autopsy and have had varying results. Some of the studies include a correlation of postmortem and antemortem levels of cardiac markers, a comparison of postmortem serum and pericardial fluid levels, and several have attempted to determine if postmortem levels are significantly higher in deaths due to myocardial ischemia than due to other causes of death. To date, though, there has not been a standardized study determining postmortem levels of cardiac markers from serum of different anatomic locations.

The current study included ten decedents, five with histories suspicious for myocardial infarction and confirmed at autopsy, and five control subjects who died of non-cardiac disease. For each decedent, six different samples (pericardial fluid and serum from the femoral veins, subclavian veins, aorta, left cardiac ventricle, and right cardiac ventricle) were drawn and tested for CK, CK-MB, and troponin-I (TnI). Three main conclusions were drawn; the levels of cardiac markers from the control group are significantly higher than the reference range for living patients; there are significant differences in the levels are cardiac markers between serum samples from different anatomic locations; and only three cardiac marker/anatomic site combinations were significantly different between the control and study groups (femoral/TnI, right ventricle/CK-MB, and pericardial fluid/CK-MB). These complete findings, a review of the literature, and a discussion about the role of postmortem cardiac markers in detecting acute myocardial damage will be discussed.

Cardiac Enzymes, Acute Myocardial Infarction, Death

G47 Histologic Evidence of Repetitive Blunt Force Abdominal Trauma in Three Pediatric Fatalities

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After attending this presentation, attendees will understand the importance of retaining sections of the retroperitoneum for microscopic examination.

This presentation will impact the forensic community and/or humanity by increasing awareness of recognizing certain patterns of fibroblastic proliferation and reactive vasculature encountered if proper sections are taken in cases of repeated child abuse.

In cases of fatal child abuse, the discovery of external blunt force trauma, skull fractures, subdural hematomas, abdominal hemorrhage, as well as retinal hemorrhages are all well described in the pediatric and forensic literature. The gross findings at autopsy, when taken into consideration with scene investigation and interviews with caregivers, point to a clear manner and cause of death in many cases. In such cases, the discovery of changes attributable to older abusive injuries helps support a conclusion of death due to inflicted trauma. Three cases of fatal child abuse in which acute blunt force abdominal trauma was the cause of death and the manner of death was homicide are presented. In each of these cases, careful examination with proper sectioning and microscopy of select abdominal tissues revealed the presence of fibroblast proliferation, increased vascularity, and hemosiderin laden macrophages indicating abdominal injuries older than the acute, fatal blunt force trauma. Iron and trichrome stains were used to highlight hemosiderin and fibrosis in all three cases; however the recognition of a fibroblast proliferation and a reactive vascular pattern was best seen on routine hematoxylin and eosin stains. These findings at autopsy, along with good investigative evidence, were helpful in establishing the diagnosis of chronic physical abuse.

Fibroblast, Proliferation, Child Abuse

G48 Death by Suicide in Maryland: A Cross-Sectional Study, 2002 to 2005

Jonrika M. Malone, MD, Ana Rubio, MD, PhD, Corey Tayman, and David M. Fowler, MD, State of Maryland Office of the Chief Medical Examiner, 111 Penn Street, Baltimore, MD 21201*

After attending this presentation, attendees will recognize the impact of suicidal deaths among various age groups, races, and between genders, allowing them to better understand that suicide as a manner of death is not isolated to the young or the old.

This presentation will impact the forensic community and/or humanity by bringing to the forefront the significance of suicide in overall mortality, detailing the different causes of death in diverse groups, and drawing epidemiologic data from the entire state of Maryland, representing the population as a whole.

Introduction: An estimated 5,600,388 individuals called the state of Maryland home in 2005 according to the United States Census Bureau. The ratio of men to women is nearly 50-50, with 48.4% and 51.6% respectively. With a population increase of 5.7% from 2000, the state is steadily growing, as is the rest of the country.

The overall rate of suicide in the state of Maryland is 8.8 per 100,000 populations per year (about 493 deaths per year). Although age (both extremes of life with adolescents and the very old being at higher risk), race (Caucasians being overrepresented) and gender (males more likely to complete suicidal deaths) are known risk factors for suicide in the literature, a detailed analysis of these and other risk factors and the

interaction with the cause of death may reveal recent trends in suicide in the Maryland population.

Methods: The Office of the Chief Medical Examiner (OCME) for the State of Maryland oversees all suicidal deaths occurring in the state. From January 2003 to December 2005 there were 1477 suicidal deaths in the state. Cases within the time frame were extracted from the OCME database, each case was reviewed, and data were analyzed for age, ethnicity, cause of death, county of residence, history of depression and/or previous suicide attempts, and whether or not there was a suicide note and of what type. Of all cases, 800 (54.2%) had a complete autopsy, 264 (17.9%) had a partial autopsy, 56 (3.8%) were inspected at the OCME, 300 (20.3%) scene inspections in respective counties, and 57 (3.9%) were approvals (cases were not examined at the office, death certificates were signed by the certifying physician and co-signed at the OCME office).

Results: Men were more likely to commit suicide (80% of the cases versus 48.4% of the Maryland population), and were slightly younger (45.7 +/- 18.7 years of age) than women (46.5 +/- 16.9 years). Caucasians were over-represented (79.1% of cases and 59.8% of the population) while the remaining racial or ethnic groups had fewer suicides than the overall Maryland rate. The rate of suicide was highest among the elderly. While 11.4% of the population of Maryland are over 65 years of age, in this study 17.4% were in that age group. The three most common causes of death were gunshot wounds (46.7%), asphyxia (26.4%) and drug intoxication (13.5%). Less common were blunt force injuries (5.5%), carbon monoxide intoxication (3.8%), sharp force injuries (2.4%), and rarely other methods (such as electrocution) or more than one method (such as gunshot wound and hanging) were employed. Suicides were fewer than expected in Baltimore City per capita and other large metropolitan areas, in part due to the different racial and ethnic mix in urban versus rural populations. The cause of death was influenced by gender [men were nearly ten times (627 cases men versus 63 cases women) as likely to use guns, whereas drug intoxication was almost equally distributed between the genders], age (there were no suicides by sharp force injuries in the adolescent group, where the most common cause of death was asphyxia due to hanging) and racial/ethnic background (asphyxia was the most common cause of death among Asian [48.6% of all suicides in this group] and Hispanics [45.2%], while gunshot wounds were the most common cause in African Americans [49.3%] and Caucasians [47.8%]).

Conclusions: A three year cross sectional study of suicide in Maryland confirmed known risk factors (male gender, Caucasian race, and old age) and also found association between these risk factors and the cause of death (suicide method). These associations may be useful in targeting efforts at prevention.

Suicide, Cause of Death, Risk Factors

G49 Can Mandibular Fractures Occur in Non-Oral Contact Shotgun Wounds of the Head?

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After attending this presentation, attendees will be aware of the characteristics of contact shotgun wounds of the head that do not directly involve the oral cavity, lower face, or mandible.

This presentation will impact the forensic community and/or humanity by demonstrating how mandibular fractures can occur with non-oral contact shotgun wounds of the head and that these fractures do not imply separate blunt force injury to the mandible.

Contact shotgun wounds of the head most commonly involve the oral cavity, submental region, temple, or frontal scalp. Although these wounds are usually suicides, homicides do occur. In all cases, autopsy findings should correlate with the investigation. Additional injury, such as a mandibular fracture in a contact shotgun wound to the temple region, must be explained in order to rule in or rule out the probability of separate blunt force injury.

The files of the Office of the Chief Medical Examiner (OCME) for the state of Maryland were reviewed for shotgun wounds to the head from January 1995 through June 2006. Review showed 215 total shotgun to the head cases with available records. Of those 215 cases, 133 were contact shotgun wounds to the head. According to available information, the location of the contact shotgun wounds included 26 cases (20%) that were intraoral, 49 cases (37%) with contact under the chin, 52 cases (39%) with contact at the level of the nose or above and 6 cases (4%) with contact at the side of the face at the mandible. Of the 52 cases with contact at the level of the nose or above, ten cases (19%) had mandibular fracture. Three of the ten cases (30%) were determined to be homicides and seven of the ten cases (70%) were determined to be suicides. Location of the shotgun wounds were right side of the head at the temple (3 cases), middle of forehead (2 cases), between the eyes (1 case), right eye (1 case), left eye (1 case), nose (1 case), and back of the head (1 case).

The gauge of the shotgun was known for seven of the ten cases with mandibular fractures. Six of the shotguns were 12 gauge (60%), one was a 20 gauge (10%), and three were unknown (30%). Of the 42 cases that did not produce a mandibular fracture, 21 were 12 gauge (50%), nine were 20 gauge (21.5%), three were .410 (7%) and nine were unknown (21.5%).

In a previous study by Harruff comparing the injury produced by different gauge shotguns, 20 of 89 cases (22%) of contact shotgun wounds of the head were located at the temple, scalp (above the level of the ears) or forehead. In these 20 cases, there was no reported difference in the internal features of the damage caused. The internal injuries included extensive fractures of the skull and maceration of the brain without injury to the facial structures. In contrast to the internal injuries, 12 gauge shotguns produced extensive external lacerations while larger gauge shotguns produced lacerations primarily at the site of contact. In the current study, the 12 gauge shotgun on average caused more extensive lacerations when compared to the larger gauge shotguns. However, both the 12 gauge and 20 gauge shotguns were able to cause a mandibular fracture.

In contact shotgun wounds of the head, fragmentation of the skull is caused by the increase in internal pressure of the skull due to the charge of the shot and the increase in pressure caused by the rapidly expanding gas from combustion of the propellant. It is postulated that this force is directly transmitted from the temporal bone to the mandible resulting in fracture.

This report emphasizes that mandibular fractures can occur with contact shotgun injuries at or above the level of the nose and that these injuries can occur regardless of the gauge of the shotgun. It is paramount not to report separate blunt force injury as the cause of the mandibular fractures without further investigation and autopsy findings supporting those conclusions. If there are allegations or concern of blunt force injury, then autopsy should show separate points of impact on the skin of the jaw area as evidenced by contusion, abrasion, or lacerations.

Contact Shotgun Wound, Head, Mandibular Fracture

G50 A Retrospective Review of Youth Suicide in New Mexico

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The goal of this presentation is to provide a brief overview of youth suicide in the United States; discuss one model of suicide and suicidal behavior; provide an overview of youth suicide in New Mexico including demographics, decedent characteristics, and circumstances of death; and discuss possible interventions to prevent youth suicide, based on the New Mexico experience.

This large-scale study on suicide in children and adolescents will impact the forensic community and/or humanity by demonstrating increasing understanding of this large (and growing) public health problem. With a solid understanding of the circumstances surrounding youth suicide, it may be possible to predict, and hopefully prevent, future cases of child and adolescent death.

Introduction: Although a suicidal behavior in children and adolescents is a major public health problem, large-scale research on suicide in this population is uncommon. Analysis of the methods and risk factors over time may permit more focused planning for suicide prevention programs.

Methods: All pediatric suicide cases referred to the New Mexico Office of the Medical Investigator from 1979 to 2005 were reviewed. For the purpose of this study, pediatric deaths were defined as deaths in the age group of one day up to and including 17 years of age. The autopsy, field investigator, and police reports were examined in detail regarding age, sex, location, and method of suicide; presence of suicide notes; and any contributing psychologic factors or stressors.

Results: There were 433 pediatric suicides during the study period, ranging in age from nine to 17; the age-adjusted suicide rate was 4.8 per 100,000 with a male-female ratio of 3.8:1. There was no significant change in gender, race, or age over time; however, there was a significant increase in the number of suicides per year. Greater numbers of suicides were observed during the months of December and February as compared to other months. Psychologic stressors were identified in some cases, such as psychiatric problems (46%) and chronic family problems including physical or sexual abuse (32%). There was a history of previous suicide attempt or suicidal ideation in 28% of the cases. Most of the suicides (76%) occurred in the victim's home or yard, and 25% left a suicide note. In 26% of cases alcohol or other drugs were detected postmortem; toxicology testing was more often positive in decedents over the age of 15 and only rarely positive in decedents younger than 15. Gunshot wound was the most common method overall (58%), followed by hanging (30%), overdose (5%), and other (including drowning, jumping from height, and blunt force vehicular trauma, 5%). Of note, hanging deaths were significantly more common among Native Americans as well as those decedents younger than 13. In addition, there has been a statistically significant decrease in deaths by firearm and a concurrent significant increase in hanging deaths.

Conclusions: Although the age-adjusted suicide rate is markedly higher in New Mexico than nationally, the trends in the regional population are similar to those seen nationally. The authors therefore present their findings in this 26-year retrospective study to increase understanding of pediatric suicides. With a solid understanding of the circumstances, it may be possible to predict, and hopefully prevent, future cases of child and adolescent death.

Adolescent, Death, Suicide

G51 A Homicide Due to a “Disguised Mail Bomb”

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Attendees will learn about a case of a homicide due to blast injuries from a bomb disguised as a package in the mail.” The goal of this study is to underline the importance of the cooperation between the forensic pathologists and the forensic laboratory section in cases of death due to explosion and the importance of the use of confocal microscope to identify the exact origin of the material present in skin samples.

This presentation will impact the forensic community and/or humanity by demonstrating the importance of histopathology in explosive-related death and the application of confocal microscope to support investigation to clarify the circumstances surrounding the death.

Explosive-related deaths fall into three types: accident, homicide, and suicide. Homicidal explosive deaths, although rare, are often associated with acts of terrorism.

An explosion following the opening of a mail package addressed to his father wounded a young Italian man. The boy was quickly taken by ambulance, but was declared dead before he arrived at the hospital. At the crime scene, along with biological material, several small and large pieces of yellow mail paper, metal, and glass fragments, and numerous shotgun pellets were collected.

Prosecutor arranged the autopsy on the body to clarify the exact mechanism of death and the correlation with the type of bomb. While undressing the body a gunshot pellet was discovered, but a preliminary total body radiographic examination exhibited no radiopaque metallic pellets within the body. A complete autopsy was performed. A large number of abrasions, burns, and contusions were present on the face, the anterior part of trunk, and upper and lower limbs. Additional solid gray metal fragments and white-gray granular material were deposited throughout the facial and trunk injuries. Eyebrows, eyelashes, head and trunk hair, were singed. Blast injury was present to left hand with skin loss, and to right hand with skin and bone loss. The posterior surface of the body was not injured. The internal examination showed confluent bruising of lungs and a band-like pattern related to the overlying ribs, bruising of the abdominal wall, both the skin and the underlying muscles, 900 cc of blood in the peritoneal cavity; extensive bruising of the gut and the mesentery; and lacerations of liver and spleen were present. Examinations of other organs were unremarkable; no fractures of ribs and sternum were detected. Routine histological investigations, applying hematoxylin and eosin staining, were performed on all organs samples. Lungs sections showed alveolar ruptures, thinning of alveolar septae, and enlargement of alveolar spaces, subpleural and intraalveolar hemorrhages, venous air embolism and soot aspiration in smaller bronchi. Fat red staining, used to document the occurrence of pulmonary fat embolism, was negative. The air embolism were confirmed by the positive results to the immunohistochemical stain for fibrinogen and CD 61 (platelet glycoprotein III a). Liver and spleen sections showed intraparenchymal diffuse hemorrhages. Samples of soot collected from the skin of face, and trunk showed a detachment of the upper epidermal areas, longitudinal elongation of the cells and nuclei of the basal cells. The cutaneous heat injuries were confirmed by the positive results by the immunohistochemical dye for HSP 90-70-27. Except for brain edema and generalized haemostasis, examination of other organs was unremarkable.

The skin samples were also examined with a light microscope, in transmitted bright field illumination and phase contrast mode, and with confocal microscope using auto-fluorescence emission of skin and metal deposited on corneum stratum and fixed in lower layers of epidermidis; a three-dimensional reconstruction of samples was performed. Fragments of the mail package were analyzed by Forensic Laboratory Section of R.A.C.I.S. (Raggruppamento Carabinieri Investigazioni Scientifiche - Grouping Scientific Investigations Carabinieri).

The trigger mechanism of the bomb was connected in turn to an electric blasting cap; such a setup affords subsequent detonation of the device. The package was a typical “disguised bomb” with the explosive contained in an innocuous appearing container.

According to the autopsy findings and histological data, death was attributed to primary blast injury (PBI). The primary blast injury arises from the overpressure of the wave that crushes the body and damages the air containing organs directly, and other organs indirectly.

The investigation of explosion-related fatalities can be a substantial challenge in forensic casework. Determining whether the mode of death is suicide, homicide, or accident in such cases can present an especially difficult task to the forensic pathologist.

Therefore the detailed forensic investigation performed with optoacoustic and histological findings, and the study of metal fragments present in the skin using a confocal type laser profile microscope at the same time the analysis of the bomb package permitted the exact reconstruction of the homicidal explosion.

Blast Injury, Confocal Microscopy, Disguised Bomb

G52 Ocular Study in Pediatric Deaths Under Two Years of Age With Novel Findings in the Retina of Children Who Died of Sudden Infant Death Syndrome (1994 – 2004)

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After attending this presentation, attendees will learn of novel findings of the retina of children who die with the diagnosis of SIDS.

This presentation will impact the forensic community and/or humanity by presenting novel findings which are easily demonstrated on routine histologic processing will aid in the understanding of a component of the pathophysiological process in children who die of SIDS.

Pediatric autopsies are considered one of the most difficult areas in Forensic Pathology, due to the small stature, different physiology, and the increased vulnerability of children to abuse.

Sudden infant death syndrome (SIDS) is defined as the sudden death of an infant less than one year of age that remains unexplained after a thorough case investigation, including performance of a complete autopsy with negative results, examination of the death scene, and review of the clinical history. SIDS is the leading cause of infant death beyond the neonatal period, mostly between one month and four months. Although the etiology largely remains unknown, many factors have been associated including metabolic, cardiac, and prone sleep position.

Differential diagnosis includes Shaken baby syndrome (SBS), subtle accidents, asphyxias, and inflicted trauma. The retinal findings are a key part of the investigation specifically identifying areas of retinal hemorrhage.

The purpose of the study was to describe ocular findings in children under two years of age who died suddenly.

One hundred two forensic pediatric cases of deaths under two years old were selected from the Regional Forensic Pathology Unit of Hamilton Ontario, over a period of 11 years (1994 – 2004).

Forensic reports were analyzed and data such as age, sex, cause of death, and postmortem intervals were obtained.

A grossing and microscopic protocol for eyes was created including description with measurements, fixation, sectioning, photography, and systematic histology.

Pigs' eyes were processed with same protocol at different postmortem intervals, as a control for postmortem tissue changes.

The majority of the cases (55%) were between one month and six months of age. The most common diagnosis was SIDS (59/102).

Seventy-two (70.5%) cases showed the presence of cytooid bodies in the retina. Cytooid bodies are smooth, rounded, eosinophilic balls that measure from 7-15 µm and can mimic red blood cells. They were located predominantly (90%) at the anterior part of retina involving the internal limiting membrane and nerve fiber layer of retina. Cytooid bodies were positive for S100, Synuclein, CD 56, and negative for Glycophorin A (an RBC marker).

Extramedullary hematopoiesis (EMH) was identified in 35 (34%) cases. The most frequent location of EMH was the choroid 29/35 (82%). Myeloid and erythroid precursors were confirmed by immunohistochemistry (myeloperoxidase and glycophorin A respectively). Electron microscopy verified the presence of neural filaments.

The changes were not seen with control samples, excluding postmortem artifact as the cause for the findings.

This study is the first to demonstrate the presence of extramedullary hematopoiesis and cytooid bodies in the retinas of SIDS children. The findings suggest a subtle hypoxic component in the natural process in SIDS. The two cases of victims of Shaken Baby Syndrome did not demonstrate EMH or cytooid bodies. Other causes of asphyxia show a 60% incidence of cytooid bodies and 30% incidence of EMH. SIDS cases did not show retinal hemorrhage.

The forensic community may benefit from these observations further aiding in the understanding of the pathogenesis of SIDS.

SIDS, Ocular Findings, Cytooid Bodies

G53 Exsanguination Associated With Vascular Access Sites in Hemodialysis Patients

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After attending this presentation, attendees will understand some principles associated with death secondary to exsanguination from vascular access sites in hemodialysis patients including the vascular access types, the frequency at which this occurs, associated circumstances under which this occurs, and possible modalities for prevention.

This presentation will impact the forensic community and/or humanity by providing a review of exsanguination deaths that are directly related to arteriovenous fistulas, arteriovenous grafts and venous catheters used for hemodialysis in patients with end stage renal disease. This information can augment knowledge of this lethal complication associated with hemodialysis and thereby reinforce the need for patient, caregiver and health personnel education and vigilance.

Patients with end stage renal failure requiring hemodialysis have three options for vascular access depending on the severity of their disease, their vascular anatomy, and their vascular viability. Native arteriovenous fistulas are the preferred choice for long term dialysis treatment because of their lower rate of breakdown and infection. Arteriovenous grafts can also be used for long term dialysis treatment if the patient's anatomy is not conducive to the creation of a natural fistula but has a greater risk of infection and clotting. Intravenous catheters are preferably used for a short duration, usually for emergency dialysis or while waiting for a fistula to mature. Exsanguination from any of these vascular access sites is a lethal complication for hemodialysis dependent patients.

A retrospective search of cases from January 2000 to July 2006 in the State of Maryland yielded 24 deaths due to exsanguination from arteriovenous fistulas, arteriovenous grafts, and venous access catheters. The age range was from 28 years to 85 years with a mean age of 58 years. Fifteen (63%) of the decedents were male. Eighteen (75%) were African American and six (25%) were Caucasian. Seven access sites (29%) were arteriovenous fistulas and four (17%) were venous catheters. Ten access sites (42%) were arteriovenous grafts. Of these ten grafts, seven (70%) were synthetic, two (20%) were made of natural materials, and one (10%) was comprised both synthetic and natural materials. Exsanguination was due to erosion of an arteriovenous graft or fistula in 14/24 (58%), dislodgement of a venous catheter in 2/24 (8%), dehiscence of graft site sutures in 2/24 (8%), infection involving a graft or fistula in 2/24 (8%), perforation of an artery following venous catheter insertion in one case (4%), erosion due to an aneurysm involving a fistula in one case, one individual who cut her venous catheter at home presumably with scissors for unknown reasons and one individual who pulled out his active dialysis line from his arteriovenous graft in the dialysis center. The manner of death was classified as accident in 11 of 24 cases (46%), as natural in nine (38%) and as undetermined in four (17%). Of the 22 of 24 cases tested for ethanol, one case tested positive. Of the 13 of the 24 cases tested for drugs, three (23%) tested positive for illicit drugs. The substances identified included cocaine and morphine. In addition to these three cases, one decedent had pseudoephedrine intoxication that was considered a contributing cause of death.

Although the complications related to vascular access sites for hemodialysis are many and varied, the results indicate that death by exsanguination is an important risk for patients. Dialysis centers should educate patients about this potential and instruct them to periodically look for signs of fistula/graft compromise including fistula/graft failure, infection, or aneurysm formation. In addition, dialysis centers should consider encouraging patients to carry a tourniquet at all times after proper training as to its use. Therefore, if a fistula/graft does erode or perforate, one can survive until emergency care can be initiated.

Hemodialysis, Exsanguination, Arteriovenous Fistula/Graft

G54 Potential Errors in Autopsy Reports of Custodial Deaths Temporally Associated With Electronic Control Devices: A Cardiovascular Perspective

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After attending this presentation, attendees will have a better understanding of Electronic Control Devices, such as the TASER® device, and how to better perform an autopsy in such cases.

This presentation will impact the forensic community and/or humanity by demonstrating more accurate autopsies where an Electronic Control Device was associated with a death.

Introduction: Sudden, in-custody death (SICD) events are alarming phenomena that occur numerous times per year in this country. With increasing usage of electronic control devices (ECD), such as TASER® brand devices by law enforcement, the number of SICD events that are

temporally related to ECD applications is growing. The autopsy in such a case presents a diagnostic challenge to the medical examiner, as there are no postmortem tests available to detect past electrical applications.

As ECD technology is relatively new, medical examiners may not be fully aware of what these devices are and are not capable of and may, therefore, be making errors in diagnostic judgment. This study analyzed the probable error rate in assigned causes of death based on a convenience sample population.

Methods: A press search for the years 2001-2005 for cases of an SICD with a temporal ECD association was undertaken and the autopsy reports obtained.

Sudden death from electrical discharge is caused by the induction of ventricular fibrillation (VF) and generally follows this sequence: (1) pulse disappears immediately, (2) there is loss of physical strength for continued resistance, (3) collapse occurs within 5-20 seconds, (4) a VF rhythm is shown on a cardiac monitor, and (5) immediate defibrillation is usually successful. Any material failure to appreciate the above facts was scored as an error.

Other errors were counted if the report reflected hypotheses not supported by known literature. These included: blaming the ECD for cardiac physical changes, inclusion of a publicity sensitive safe comment (e.g., "we were unable to eliminate the role" of the ECD), assuming prolonged ECD applications are more dangerous than other restraint techniques, claiming that ECDs impair breathing, presumption of a lethal synergy between stimulant drugs and the ECD, use of the ECD in the "drive stun" mode only since this involves current passing between two very close electrodes and does not create any major body mass involvement. Finally, the use of the metaphorical "last straw" was scored as an error.

Results: There were 176 SICD events reported over the 60 month period with a temporal ECD association. Twenty-Seven cases where the autopsy reports listed the ECD as a contributory or as an "unknown" factor. As expected, the rate of such reports appears to be growing at 2.6 per year ($r^2=.74$, $p = .06$). Autopsy reports were reviewed for these cases and errors were tabulated. The decedents were all male with mean age 35.6 ± 10.7 years (median = 32) which is consistent with recently reported SICD data.¹ A mean of 3.1 ± 1.2 scored errors per report with a range of 1-6. This rate was very stable across the study period. A sobering finding was the rate at which "last straw" was mentioned as a linkage in lieu of a scientific mechanism. Scored errors are listed in the following table:

Probable Error in Citing the ECD	N
Time to collapse \geq 1 minute	21
Continued resistance after ECD application	14
Rhythm other than VF	11
Publicity sensitive comments	9
Failure of immediate defibrillation	7
Drive stun mode	6
Assumed drug-ECD electrocution synergy	6
Discharge duration or parity	5
"Last straw" metaphor as a mechanism	4
Cardiac damage ascribed to ECD	3
Assumed ventilation impairment	2

Conclusions: While uncommon, autopsy reports involving electronic control devices do appear several times per year with material errors in the area of cardiogenic etiology. The results of this study suggest that medical examiners need to familiarize themselves with the time and causation elements of electrocution, ventricular fibrillation, and ECD technology to avoid this in the future.

Reference:

¹ Ho JD, Reardon RF, and WG Heegaard. Deaths in police custody: an eight month surveillance study. *Annals Emerg Med*, 2005;46 (suppl):S94.

Electronic Control Devices, TASER®, Autopsy

G55 Headache and Sudden Death in a Young Adult: An Unexpected Finding at Autopsy

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After attending this presentation, attendees will have gained a basic understanding of the different ways humans can contract *Taenia solium*, the pork tapeworm, and the different diseases that can develop from infection with this parasite, emphasizing involvement of the central nervous system.

A 33-year-old white female presented with a history of severe headaches, nausea, vomiting, and dizziness. The headaches, which were unassociated with fever, began in February 2006. A work up for meningitis including examination of cerebral spinal fluid was negative, resulting in a diagnosis of migraine headaches. The headaches and accompanying symptoms, however, persisted. Following an episode of one of the headaches, she was found unresponsive in bed and was unable to be resuscitated.

Autopsy examination revealed the presence of cerebral edema with tonsillar herniation. The posterior horns of the lateral ventricles in the temporal region were dilated. The fourth ventricle was dilated and obstructed by a colloidal appearing cystic structure that measured 1 cm in maximum dimension. The remainder of the autopsy examination was unremarkable. Blood cultures were negative, vitreous electrolytes showed a normal postmortem pattern and were unremarkable, and toxicology testing was negative.

Histologically, the brain showed an intense mononuclear infiltrate composed of lymphocytes and plasma cells that surrounded a homogenous amorphous eosinophilic structure in the ventricle. The choroid plexus focally showed a similar intense inflammatory reaction. Ependymitis and mononuclear perivascular cuffing were also present. The cystic structure seen grossly in the fourth ventricle had a wall that was composed of three layers: an eosinophilic outer cuticle with the grapelike appearance, a single layer of subcuticular cells, and a myxoid cytoplasm containing tubular structures. These findings are consistent with intraventricular neurocysticercosis.

Upon further questioning of the family, it was learned that the decedent had immigrated to the United States from Mexico 12 years ago. Her family in Mexico owned a restaurant type business where pigs were raised and slaughtered on the property. Prior to her recent complaints of headache, the decedent had been in good health.

Cysticercosis is the most common parasitic disease affecting the central nervous system. It is endemic in Latin America, India, China, Southeast Asia, and sub-Saharan Africa. It is estimated that up to 90 percent of patients with cysticercosis have central nervous system involvement. Sole involvement of the central nervous system is termed neurocysticercosis (NCC). The disease is reported in all age groups, but most cases present in the third and fourth decades. Reliable data regarding the incubation period are lacking, but it is estimated that months to decades can pass between initial infection/exposure and the subsequent development of neurological symptoms.

The pork tapeworm *Taenia solium* causes the infection. Humans can be either the definitive host or the intermediate host and thus two different diseases are recognized. Infection with the larval form as would occur from eating contaminated undercooked meat leads to taeniasis. The larva hatches in the small intestine and develops into tapeworms. In this situation humans are the definitive host because they harbor the adult form of the parasite – the tapeworm. In contrast, when humans harbor the larval form of the parasite, they are the intermediate host and the disease is called cysticercosis. This occurs when *T. solium* eggs are ingested. Sources of eggs include contaminated food and water, fruit, or vegetables fertilized with contaminated human or pig feces and contact with individuals harboring the tapeworm and shedding the eggs. The disease may be

contracted from fomites because the eggs are resistant to environmental conditions.

In the small intestine the eggs hatch releasing oncospheres. The oncosphere penetrates the intestinal mucosa, travels to the pulmonary circulation, and is disseminated systemically. The oncosphere, which develops into the larval form, may reach several different organ systems, but seem to have a predilection for the central nervous system, skeletal muscle, subcutaneous tissue, and eyes. Central nervous system involvement most commonly involves the parenchyma and may cause seizures.

Involvement in the central nervous system may be extraparenchymal affecting the ventricles, subarachnoid space, eyes, and spinal cord. It is estimated that between ten to 30 percent of patients with NCC have intraventricular cysts. Ventricular cysts can be attached to the ependyma or float freely migrating throughout the cerebral spinal fluid pathways. Unlike parenchymal cysts, which are typically multiple, ventricular cysts tend to be solitary and ventricular involvement typically occurs without accompanying parenchymal cysts. Ventricular cysts are more likely to be symptomatic than parenchymal cysts. Ventricular cysts can cause hydrocephalus either by blocking the flow of cerebral spinal fluid or by producing ependymitis with scarring, obstruction, and ventriculitis. Individuals having involvement of the ventricle most commonly present with signs of increased intracranial pressure such as headache, nausea, and vomiting. These symptoms are commonly attributed to migraine or tension headaches.

NCC is generally a chronic disease whose natural progression includes four stages: vesicular, colloidal, granular/nodular and calcified. Symptoms typically develop as the parasite begins to die losing its ability to control host defenses. The ensuing inflammatory response results in degeneration of the larva and the formation of a granuloma.

Making the diagnosis in a clinical setting can be difficult because the clinical manifestations are variable and nonspecific and depend on the number and location of cysts and the host's immune response. Proposed diagnostic criteria incorporate absolute, major, minor, and epidemiological criteria. Interpretation of the criteria allows for two degrees of diagnostic certainty – definitive and probable.

No reliable information is available regarding mortality rates. Large autopsy series from endemic areas suggests that the majority of cases are asymptomatic making calculation of the true incidence and prevalence difficult. It is estimated that 50 million people are infected worldwide. The disease carries a high cost in morbidity. In endemic countries NCC may be responsible for 50 percent of adult-onset seizure disorders and those with intraventricular and subarachnoid involvement can develop complications such as vasculitis and hydrocephalus. The annual treatment cost in endemic areas is estimated to be close to \$90 million per year. In the United States, there are more cases of imported NCC than in all other developed countries combined, and the annual treatment cost is estimated at \$9 million per year. The disease is generally encountered in the southwest United States and among Hispanic immigrants. The increasing number of reported cases in the United States is most likely due to increased immigration and travel to endemic areas. The long latent period and variable clinical presentations make it go undetected or unrecognized clinically. Although autopsy studies suggest that NCC is most commonly an incidental finding, the disease can result in death. NCC should be considered in the differential diagnosis of calcified, nodular, or cystic lesions of the central nervous system.

Neurocysticercosis, Headache, Central Nervous System

G56 Sudden Death in Duchenne Muscular Dystrophy With Noncompaction of the Ventricular Myocardium: A New Cardiomyopathy or a Compensatory Regression to Fetal Myocardiogenesis?

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The goal of this presentation is to evaluate morphologic changes in the myocardium critically in order to gain insight into their role in the pathogenesis of apparent cardiomyopathies. What may appear initially to be a primary derangement in cardiac muscle (the definition of cardiomyopathy) may in fact be a secondary response to another primary insult.

This presentation will impact the forensic community and/or humanity by creating an awareness of an abnormal morphologic pattern within the myocardium and the spectrum of its association with disease states, particularly the muscular dystrophies.

Noncompaction of the ventricular myocardium (NVM) is a condition describing a rare type of cardiomyopathy believed to be due to an interruption in cardiac development. It refers specifically to persistence of the trabecular network of sponge like cardiac muscle that accompanies mid- to late embryonic development, during which time the myocardial blood supply is provided by direct diffusion from the intertrabecular spaces that communicate directly with the cardiac chambers. NVM may occur either as an isolated condition, in association with other structural heart derangements, or as part of a syndrome of anomalies. NVM has been described as a component of several muscular disorders and mitochondriopathies, including Barth syndrome, Becker muscular dystrophy, Emery-Dreifuss muscular dystrophy, myoadenylate deaminase deficiency, myotubular and metabolic myopathies, and with mutations in the G4.5 and a-dystrobrevin genes (Xq28 chromosome region), with possible X-linked inheritance. However, until quite recently, an association between NVM and Duchenne muscular dystrophy (DMD) had not been realized. This presentation describes a case of sudden death in the setting of DMD complicated by dilated cardiomyopathy (DCM) in which autopsy revealed a prominent finding of NVM; in doing so, this study attempts to explore a potential causal relationship between the DCM and NVM.

The deceased was a 21-year-old African-American man with DMD (wheelchair-bound) and DCM; a recent echocardiogram documented global hypokinesis with a left ventricular ejection fraction ranging from 20-30%. Five days before his death, he presented with an acute exacerbation of congestive heart failure and tricuspid regurgitation. On the day of his death, his caregiver called 911 for complaints of profound weakness; paramedics recorded a mean blood pressure of 65 mm Hg. He was transported to the Emergency Department and was administered crystalloid intravenous fluids, which restored his blood pressure to 91/51. However, despite being stable for the next few hours, he experienced a witnessed seizure that was followed by a thready carotid pulse, and shortly after, by pulseless electrical activity (PEA). Resuscitative efforts were initiated and were carried out for approximately 10-15 minutes but were unsuccessful and he was pronounced dead.

At autopsy, the deceased exhibited marked flexion contractures of the hips and knees and there was extensive fatty replacement of the calf and psoas muscles. There were unequivocal features of DCM, including a 550-g heart (expected for body weight: 223 g), moderate to marked left ventricular dilatation and patchy but focally confluent areas of dense white fibrosis, individually up to 0.6 cm, involving the posterior and lateral left ventricular walls. In addition, there was marked exaggeration of the trabeculae carneae within the left ventricular chamber, with numerous anastomosing trabeculae that imparted a distinctly "spongy" appearance, particularly at the left ventricular apex. Microscopic cardiac examination

revealed confluent replacement fibrosis and fatty ingrowth within the compact outer myocardial half, while the inner half consisted of an anastomosing network of trabeculae forming irregular “staghorn”-like spaces. The cause of death was certified as complications of DCM (associated with NVM) due to DMD.

In late 2005, NVM was described for the first time in a patient with DMD by a group of investigators in Vienna, Austria. They proposed that in the setting of DMD, replacement fibrosis of the compact myocardium following myocyte loss is the principal pathologic finding and accounts for the clinical spectrum of ventricular dysfunction in these patients, while NVM represents a compensatory response generated by a failing heart to regenerate its nonfunctional myocardium. The case presented represents the second reported association between NVM and DMD. This study proposes that the precise molecular signals governing the events in embryonic cardiogenesis may be recapitulated in certain clinical settings, such as this one; identification and isolation of such signals would corroborate this hypothesis and enhance the understanding of such events.

Noncompaction of the Ventricular Myocardium, Dilated Cardiomyopathy, Duchenne Muscular Dystrophy

G57 Death By Giant Cells: Report of Two Cases of Sudden Cardiac Death Due to Giant Cell Inflammatory Processes

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After attending this presentation, attendees will be familiar with the differential diagnosis in cases of sudden cardiac death due to giant cell inflammatory processes involving the myocardium and will understand the roles of histologic examination and immunohistologic studies in arriving at the correct diagnosis.

This presentation will impact the forensic community and/or humanity by elucidating the clinical and pathologic issues involved in distinguishing the subgroup of sudden cardiac deaths resulting from inflammatory processes with giant cells that affect the heart.

The medical examiner or coroner usually investigates sudden and unexpected deaths in individuals without documented disease processes that would provide reasonable explanations for the deaths. These include the unexpected deaths of individuals who have been diagnosed with a known chronic natural disease that was not expected to cause death at that point in time as well as those cases in which the deceased had no known pre-existing natural disease at the time of death. Cardiovascular disorders, most notably arteriosclerotic and/or hypertensive cardiovascular disease, account for the majority of sudden and unexpected natural deaths. Less commonly documented are disease processes directly affecting the myocardium. In these cases, histologic examination of the myocardium is often essential in reaching a diagnosis.

Granulomatous inflammation of the myocardium can occur in the course of a number of systemic disease processes including infectious etiologies such as fungal, mycobacterial and parasitic infections, as well as hypersensitivity reactions and rarely autoimmune disorders. In many of these disorders giant cells comprise a component of the inflammatory infiltrate. Systemic granulomatous processes of unknown pathogenesis, most notably sarcoidosis, may also be associated with involvement of the myocardium. In contrast, giant cell myocarditis, also known as idiopathic myocarditis, a rare, frequently fulminant, and fatal disorder of unknown etiology, is isolated to the heart and lacks systemic involvement.

The majority of systemic granulomatous disorders that involve the heart are diagnosed prior to death due to their protracted clinical course and symptomatology related to the involvement of other organs.

Occasionally, however, these disorders are associated with sudden death due to pathologic involvement of the heart. These cases are likely to be investigated by a forensic pathologist, particularly if the individuals do not have antemortem diagnoses. Because of its isolation to the heart and rapid clinical course, giant cell myocarditis is most likely to be diagnosed at the time of autopsy. Indeed, an individual may be asymptomatic and sudden death may be the presenting manifestation of the disease.

This study reports two cases in which sudden death resulted from giant cell inflammatory processes affecting the myocardium. Both individuals lacked antemortem diagnoses. In one case an 18-year-old man who had been asymptomatic except for a 2 ½ month history of vague abdominal pain was found dead at work. Postmortem examination revealed a semigranulomatous, mixed inflammatory cell process involving the left ventricle that was associated with giant cells and lacked myocardial fiber necrosis and tissue eosinophilia. Numerous well-formed, noncaseating granulomas were found in the lungs, pulmonary hilar lymph nodes and kidneys. The diagnosis of sarcoidosis was rendered. The second case involved a 43-year-old man with a ten year history of intermittent chest pressure and cardiac arrhythmias who collapsed at work. The heart showed a similar mixed inflammatory cell infiltrate that included giant cells, although focal myocardial fiber necrosis and eosinophils were also present. Thorough gross and microscopic examination revealed no involvement of other visceral organs or lymph nodes and the diagnosis of giant cell myocarditis was rendered.

Giant, Cell, Myocarditis

G58 Sudden Death and Keratoderma Associated Cardiomyopathy: An “Affray” of the Heart

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After attending this presentation, attendees will have knowledge of cardiomyopathy associated sudden death and keratoderma as well as the law regarding manslaughter in England.

This presentation will impact the forensic community and/or humanity by discussing issues of interaction of sudden “natural” death and the law pertaining to homicide in England.

A 15-year-old girl was involved in an incident in which she was subject to threats, then blows before running away from the incident. She ran uphill away from the incident, collapsed and died. At autopsy a history was given that she suffered from the skin disorder Erythrokeratoderma Variabilis or possibly Papillon-Lefèvre syndrome and was on antihistamines. At autopsy there was significant thickening of the skin, most obvious of the palms and soles of the feet. The hair was abnormal as were the teeth. On internal examination the heart was clearly abnormal. There was a degree of dilatation of the ventricles and on microscopic examination there was obvious fibrosis, with no evidence of acute infarction or inflammation. A diagnosis of Plantopalmer Keratosis associated cardiomyopathy was made.

There are a number of genetic abnormalities associated with Plantopalmer keratosis. A number of heart conditions may be found including Naxos syndrome and Carvajal syndrome.

A charge of manslaughter, with an additional charge of affray was laid against four teenage defendants. The basis of the manslaughter charge was the charge of affray, except for brain edema and generalized haemostasis. Three of the defendants were convicted of manslaughter and affray. The fourth defendant was acquitted.

On appeal, the convictions for manslaughter were overturned. The convictions for affray were upheld. As well as the unique pathologic features, this case has clarified the law of manslaughter in the English legal system, limiting its extent to an act that is dangerous in the sense that sober and reasonable persons would recognize it as foreseeable.

¹ Reference:

R v Carey, C and F (2006) EWCA Crim 17

Cardiomyopathy, Homicide, Keratoderma

G59 Correlations for Expected Heart Weight

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After attending this presentation, attendees will understand the use of correlations with height, weight, and Body Mass Index (BMI) to determine expected normal autopsy heart weight as well as variations in expected heart weight by sex and appreciate the deviation from expected heart weight as an indicator of heart disease.

This presentation will impact the forensic community and/or humanity helping to define abnormal heart weight in sudden and unexpected deaths and will explore the epidemiology of heart disease and the effect of BMI on heart weight.

After attending this presentation attendees will understand that the correlation of height, weight and Body Mass Estimation with expected normal heart weight is important to identify subtle hypertrophy, especially in the analysis of sudden and unexpected deaths with minimal disease. Standard references define normal ranges for heart weight at autopsy and there are published correlations of autopsy heart weight with body weight and body length. Body Mass Index (BMI) is commonly used as an indicator of obesity and obesity has been correlated with heart disease. This study explores the relationship of heart weight at autopsy to BMI as calculated from length and body weight data measured as part of the routine autopsy procedure.

This study reviewed reports of all autopsies performed in 2004 at the Richmond District Office of the Chief Medical Examiner. Data collected from each case included age, sex, race, height, weight, heart weight, and presence or absence of anatomically identifiable heart disease. Cases were excluded where there was extensive decomposition, burning, or other body destruction that could invalidate the height, body weight or heart weight data. While the collected data contained decedents of all ages, the study focused on adults between 18 and 65 years of age.

Correlations of heart weight with body weight in patients without identifiable heart disease were generally good and in agreement with previously published data. Similar correlation lines for patients with heart disease were significantly different with the expected bias toward increased heart weight. Comparison of correlations for men and women also produced significant and expected differences. Surprisingly, correlations of heart weight with BMI were much worse than the correlations with body weight.

Body Mass Index (BMI), Heart Disease, Heart Weight

G60 Gaggling, Strangulation By Single/ Double Ligature ...or Incaprettamento?

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After attending this presentation, attendees will learn that some apparent simple cases of strangulation turn out to be complex ones, with more than one form of mechanical asphyxia involved. This presentation

will also point out how important is to know the mechanism of death in these cases to be able to reconstitute the story.

This presentation will impact the forensic community and/or humanity through the familiarization with this particular ritualistic way of committing homicide – the *incaprettamento* - practiced not only within the community where it was originally described. Additionally the presentation will emphasize the importance of the differential diagnose between the diverse forms of mechanical asphyxia used in a single victim.

Incaprettamento is a typical homicide ritual used by the Italian Mafia as an admonitory significance to traitors and considered a form of vendetta. A rope is tied in a noose around the victim's neck. The other end of the rope is used to tie both hands and feet behind the back. Death is attributed to self-strangulation when, by exhaustion, the victim will no longer be able to support the legs in that forced position. Some authors point out that sometimes, the binding is done postmortem, to facilitate transportation and disposal of the victim.

This research presents a case of a man partially naked, who had been apparently gagged and strangled, with the hands and feet tied at the back, seeming to be a case of *incaprettamento*. He was found in a forest, some meters away from the local road, in a prone position with the head lower than the rest of the body.

The autopsy showed that the victim had been gagged, apart from having two constrictor items around the neck: a ladder belt (which tied simultaneously both hands behind the back, with a twisting device made of a metal part of a bicycle inserted between the rope and the skin) and, underneath it, a synthetic rope. The feet were bound with an electric wire, separately from the hands. Typical ligature injuries were observed, such as asphyxic exuberant signals, osteo-cartilagenous fractures, intimal tear of the carotid artery and bleeding into the muscles and mucosa. A sexual assault was ruled out using a standard protocol for collection and evaluation of the usual specimens.

Taking into account the autopsy diagnoses – gagging and/or a single/double ligature – this paper discusses the real cause of death, and its relation with a case of *incaprettamento*. Finally, this presentation will debate whether this could be considered a real *incaprettamento*, since, contrary to the typical procedure involved in this type of homicide; the feet were bind independently, without being attached to the hands and neck.

Incaprettamento, Strangulation, Gaggling

G61 A Case Report of an Unexpected Accidental Electrocutation

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After attending this presentation, attendees will understand basic principals of investigating accidental electrocutions and will also have an increased index of suspicion for electrocution in certain cases of sudden, unexpected death.

This presentation will impact the forensic community and/or humanity by increasing awareness of electrocution as a differential diagnosis in certain circumstances and by emphasizing the importance of a multidisciplinary approach to complete scene investigation in cases of possible electrocution. By increasing the detection of cases of electrocution, particularly those taking place in public areas, potentially hazardous or fatal electrical malfunctions, and situations can be detected and corrected before causing death or harm to additional individuals, including the investigators.

Fatal electrocutions are reported to account for a death rate of approximately 0.54 per 100,000, occur most commonly in men, and are mostly accidents (though suicides and homicides by electrocution do occur). The mechanism of death during electrocution varies, but is often due to ventricular fibrillation. Electrocutions can be categorized into direct current and alternating current types, and alternating current is generally regarded as more dangerous than direct current. Electrocutions can also be divided into high and low-voltage varieties (based on voltage greater than or less than 1000 volts), and, though the exact ratio of high versus low-voltage electrocution varies with the study, up to 83% of electrocutions are with low-voltage current. While high-voltage electrocutions are often accompanied by characteristic electrical burns, nearly 50% of low-voltage electrocutions are not accompanied by these burns or other physical evidence, which renders postmortem diagnosis potentially difficult. Indeed, even some characteristic features of high voltage electrocutions, such as the arborescent patterns seen in fatal lightning strikes, may be transient. This lack of specific pathologic findings makes a high index of clinical suspicion very important in certain circumstances, such when a person is grounded and near a source of electricity. Additionally, examination of the victim's clothing for burns and death scene investigation are of critical importance in detecting electrocution. Numerous authors have also stressed both the critical importance of scene safety and of a multidisciplinary approach during the investigations of potential electrocutions. Specifically, electrical engineers or representatives of a local power company are often called upon to examine electrical devices that potentially caused the electrocution.

To illustrate these points, this presentation will describe a case of accidental low-voltage electrocution that occurred in their practice. In this case, a 28-year-old male was found dead in a publicly accessible restroom. The initial report, accompanying the decedent to the county coroner's office, stated the death was believed to be a natural death; however, examination of the decedent revealed burns on the skin and clothing. Based upon these burns, which were believed to be electrical, additional scene investigation was requested by the forensic pathologist. This supplemental investigation disclosed that another individual had complained of receiving a "shock" in that restroom. Also, a representative of the local power company went to the scene and discovered two separate electrical devices that were defective and could have exposed the decedent, or other users of this restroom to low-voltage current, a risk that was heightened by a wet floor with a metal drain. A subsequent report that correlated the scene findings with the pattern of electrical burns on the victim's skin, suggest that both pieces of equipment contributed to the death of the decedent. This case serves to illustrate the potentially occult nature of low-voltage electrocutions and how a multidisciplinary scene investigation as well as expert examination of involved electrical equipment can greatly aid in the detection of such electrocutions, which can have an impact on public safety.

Electrocution, Fatal, Accidental

G62 Death From Truck Tire Servicing: A Report of Three Cases and Review of the Literature

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After attending this presentation, attendees will recognize different blunt force and blast type injuries associated with truck tire servicing accidents.

This presentation will impact the forensic community and/or humanity by helping in the recognition of the different blunt force and blast type injury patterns; and helping the attendee to be better aware of

OSHA regulations and manufacturers' recommendations for proper tire servicing.

Three cases of death from injuries related to truck tire repair and/or handling were identified between 1995 and 2006 at the King County Medical Examiner's Office in Seattle, WA. The decedents, all male, ranged in age from 30 years to 40 years old and had no significant medical conditions. Injuries ranged from blunt force trauma to the head, torso and extremities to blast injuries of the upper airways and lungs.

In the first case, the decedent made an unwitnessed service call to change a tire on a tractor-trailer truck parked in a lot. Evidence suggested the individual had changed the tire and was in inflating the new tire when the sidewall blew out. The decedent was struck in the face and fell backward. Autopsy showed contusions to the lungs, esophagus, posterior pharynx, and superior larynx.

In the second case, a warehouse worker was rolling semi-truck wheels and tires onto metal racks. A supervisor witnessed a tire explode projecting the wheel upward into the decedent's head, chest and arms, projecting him backwards. Autopsy showed comminuted skull fractures, cerebral lacerations, multiple rib fractures, and pulmonary contusions.

In the third case, the decedent made an unwitnessed roadside service call to change a dump truck tire on an access road. He was found supine on the ground with the tire and wheel resting across his legs. Examination of the injuries and scene reconstruction demonstrated tire explosion during inflation and upward projection of the wheel. Autopsy revealed a depressed frontal skull fracture and parietal and frontal scalp lacerations with associated cortical contusions and subarachnoid hemorrhage.

Review of the literature revealed well documented patterns of injury and death associated with explosions during tire servicing and handling. The vast majority of fatalities from all tire servicing accidents involve service work on truck tires. Blunt force injuries to the head accounted for the majority of these fatalities, while other common injuries include broken facial and upper extremity bones. Other documented injuries included "blast" or concussive injuries to air-filled organs such as bowel, lung, and tympanic membranes. This study reviewed several manufacturers' standard safety procedures as well as OSHA regulations and found a general concordance on the proper equipment needed when changing a truck tire and on the proper procedure. These include using protective gear and using safety equipment. Proper tire changing procedure was outlined as a multi-step process with clear check points to be met before proceeding onward. The prevention of these types of injuries can best be accomplished by adherence to the tire manufacturers' warnings and recommendations as well as to OSHA's tire service regulations. There is precedent for the levying of fines against businesses not in compliance with OSHA workplace safety standards.

When investigating these frequently unwitnessed deaths, particular attention needs to be paid to scene investigation, noting if proper procedures and equipment were being employed. This is important not only to rule out foul play, but for ease of reconstruction of events leading to death when correlated to injuries found at autopsy.

Blunt and Blast Force Injuries, Truck Tire Servicing Accidents, OSHA

G63 A Rare Injuring Tool in a Dyadic Death

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After attending this presentation, attendees will have a better understanding of cases involving a homicide and suicide (HS). Only few cases of homicide-suicide by carpenter axe are reported in forensic literature. Sometimes it may be difficult for the forensic pathologist to distinguish between a real HS and a double murder. The importance of a thorough forensic investigation, including crime scene evaluation,

analysis of circumstantial data, autopsy findings, toxicological analysis, histological and immunohistochemical studies is emphasized.

This presentation will impact the forensic community and/or humanity by presenting the case of a homicide-suicide, where the murderer chopped his wife with a carpenter axe, and then he hanged himself. The unusual injuring tool and the relevant injuries were studied and analyzed to approach the case of dyadic death. The confocal microscope was utilized to verify the three dimensional appearance of the cutaneous lesions

Homicide-suicide (HS) is defined as that lethal event in which an individual kills another and subsequently commits suicide within one week. International studies report a highly variable proportion of HS in all homicides (from 1.5% of all recorded homicides in USA, to 42% of Denmark). Some authors proposed that the higher is the homicide rate in a population; the lower is the rate of HS. Per capita rates of HS, instead, appears quite constant across different countries and through time, in fact the annual incidence varies from the 0.2-0.6/100,000 in US, 0.07/100,000 in England and Wales, 0.18/100,000 in Finland, and 0.22/100,000 in Hong Kong. In Italy, in an observational period of 15 years, 1985 – 1999 it has been observed that the higher rates concern the Northern Italy (0.85/100,000), followed by the Central Italy (0.68) and the Southern region (0.38). Previous studies have outlined that the HS perpetrators show more similarities with those who commit suicide rather than with those who commit homicide. The vast majority of offenders are male (75-97%), aged 35-51 years, while the victims are generally female (60-85%), aged 30-35 years. Offenders are often apparently free of mental disorders, but some are regarded by relatives and friends as “hot tempered”; a low percentage have a diagnosis of major depression or psychotic disorder. The great majority of HS occurs between intimates (spouses and cohabitant) and family members. The largest group comprises the spousal or lover killing, followed by the homicide of children, and than of other family members. Male offenders usually kill spouses, while female perpetrators generally commit child homicide. The most frequent trigger is represented by the imminent separation or ending of an intimate relationship. Many modes of killing are described like shooting, strangling, stabbing, chopping, gassing, or poisoning, beating, etc. There exists a significant difference between male and female offenders in the method chosen to kill: in fact, while men are more prone to adopt active methods, women tend to use passive methods.

Here is a case of HS, where the husband chopped his wife at the back of the neck, resulting in a complete transection of the cervical spinal cord, and than hanged himself. A boy with a friend came back home and found the lifeless body of his mother lying face down in a large pool of blood. At a distance of two m, they saw the body of the father hanged by a strong nylon rope to the banisters of the mezzanine. Immediately they tried to help him, releasing his head from the slip knot, and called the ambulance, but they were both pronounced dead. In the adjacent room, policemen found a carpenter axe on a table, stained with blood and locks of hair. On the floor beneath the axe a large pool of blood was evident, with extensive blood spatter on the surface of the door and the adjacent wall. This pool of blood started a trail of blood terminating at the woman's body. The postmortem examination of the female deceased showed a deep linear cutaneous wound on the back of the neck, 6.5 cm in length, slightly oblique, with clear-cut divergent margins, exposing the underlying structures, with soft tissue bleeding underneath. A red colored area, 7.5 x 2.5 cm in diameter, surrounded this wound. The body of the second cervical vertebra showed a transverse fracture, passing underneath the dens and the right superior articular facet. The spinal cord was completely transected at the level of C₂. Also a complete section of the left vertebral artery was visible. No relevant injuries were detected on the remained of the body. Autopsy of the male revealed a ligature mark on the neck. In both cases, the histological investigation revealed massive hemorrhages in the cutaneous and subcutaneous tissues. Infiltration of erythrocytes in the dural layers and in the spinal cord was evident, at the level of transaction of the spinal cord in the female victim. Immunohistochemical studies

were performed on the cutaneous specimens collected from the neck lesions for the determination of the vitality. The evaluation of skin samples with confocal microscope allowed researchers to observe the three-dimensional model of the strangulation mark and the chopping wound. Toxicological analyses were negative.

Homicide Suicide, Chopping Wound, Immunohistochemical Study

G64 Independence Day Explosion on Lovers Key

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After attending this presentation, attendees will have an understanding of the unique aspects and hazards involved in the investigation of the scene of a pyrotechnics explosion and in the postmortem examinations of the victims.

This presentation will impact the forensic community and/or humanity by providing an understanding of the unique considerations and hazards that should be taken into account by medicolegal death investigators and forensic pathologists involved in the investigation of deaths due to fireworks-related incidents.

Fireworks, generally recognized as having originated in China, have been popular in the United States since the mid-19th century. They are traditionally used in the celebration of Independence Day on Fourth of July, as well as other holidays. Because injuries due to recreational fireworks-related incidents among consumers are relatively common, the sale of fireworks is regulated by federal law and is also limited by state and local laws. Most injuries occur in children and in individuals actively handling the fireworks and most commonly involve the hands, face and eyes. In contrast, because fireworks display companies are under tight safety regulations, explosions in the professional pyrotechnics industry are rare.

This study investigated the scene and postmortem examinations of the victims of an explosion and resulting fire that occurred on Lovers Key in southwest Florida while a pyrotechnics crew was transferring fireworks from a semitrailer to a smaller truck in preparation for a Fourth of July display. The company had planned to use 853 fireworks shells ranging 3- to 12-inch in diameter and up to 4 feet long. The scene investigation involved eight teams of 80 people from multiple agencies, including the local fire department, the State Fire Marshall's Office, the Sheriff's Office, the Regional Bomb Squad, the Bureau of Alcohol, Tobacco, Firearms and Explosives, OSHA and the Medical Examiner's Office. The 40 hour investigation of the scene presented unique hazards because of flare-ups of the fire, a secondary explosion and because the debris included live firework shells. The potential detonation of live ordnance necessitated leaving the bodies at the scene until a thorough search was performed. The live rounds were marked and left in place until they were later secured in wet sand for removal and destruction. The investigation subsequently determined that the explosion was due to the accidental ignition of the fireworks, although the exact cause was never identified.

Four of the six members of the fireworks crew died at the scene, and later another later succumbed to thermal injuries. Two of the bodies at the scene were relatively intact, while the other two were fragmented. The sixth worker, a woman who was the farthest away from the trucks, jumped into a nearby body of water and survived although she suffered burn injuries and smoke inhalation. The identification of the decedents was made either by dental comparison and/or the comparison of pre- and postmortem radiographs of the axial skeletons. The autopsies also involved unique considerations due to the possible presence of unexploded ordnance in the bodies, necessitating total body radiographs prior to the examinations, because of the possibility of friction causing the detonation of these rounds. Injuries included thermal injuries resulting from the fire as well as blunt force injuries caused by the exploding fireworks and by structural materials from the destroyed vehicles. The

two relatively intact bodies showed penetrating wounds, predominately superficial, containing fireworks pellets and dark burning soot. There were no characteristic injuries to air-containing hollow viscera due to shock wave effects.

Fireworks, Explosion, Fatality

G65 Identifying the “Iceman”

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After attending this presentation, attendees will understand how the use of mtDNA can aid in the identification of missing service members from decades-old skeletal remains.

This presentation will impact the forensic community and/or humanity by providing the attendees with an example of the uses of mtDNA for the identification of human remains exposed to harsh environmental conditions.

The Armed Forces DNA Identification Laboratory (AFDIL) and the Joint POW/MIA Accounting Command-Central Identification Laboratory (JPAC-CIL) work in a combined effort to identify missing or unidentified personnel from past military conflicts. With the use of mitochondrial DNA (mtDNA) testing, skeletal remains are analyzed and compared to references from associated family members in order to make identifications. The following case study from World War II shows how the use of mtDNA can aid in the identification of missing service members from decades-old skeletal remains.

On November 18, 1942, 2d Lt. William Gamber and student Aviation Cadets John Mortenson, Ernest Munn and Leo Mustonen of the 41st School Squadron, departed Mather Field, California, for a 4-hour navigational training flight. Five hours after their departure, and with no communication from the AT-7 aircraft, search crews were sent out to locate the flight team. However, with no position reports during the flight, search crews did not know where to look in the mountainous terrain of the flight's route. After search parties found no remnants of the aircraft or its crew, the United States Army Air Forces (USAAF) abandoned its search. On November 9, 1943, the War Department officially declared all four men as dead.

Almost five years later, on September 24, 1947, two students found portions of an aircraft approximately 120 miles east of Los Banos, California. Search parties came upon widely scattered wreckage, including two engines, embedded in the ice. A data plate from one of the engines matched that from the missing AT-7 aircraft. Remains found at the site could not be identified and were interred in a group burial in the Golden Gate National Cemetery, San Bruno, California.

Decades later, on October 15, 2005, two hikers came upon a body, partially encased in ice in Mendel Glacier in Kings Canyon National Park. No evidence was found to immediately identify the body, but an undeployed U.S. Army parachute was strapped to the body, indicating that of a military service member. The National Park Service then contacted the JPAC-CIL to assist in the recovery. JPAC-CIL removed the remains as well as some material evidence from the body. Historical evidence associated with the loss of the AT-7, and evidence recovered in 1947 and 2005, suggested that these remains were likely one of the four men aboard this aircraft when it was reported missing on November 18, 1942.

The remains arrived at the CIL in Honolulu, Hawaii where a thorough anthropological analysis was made. On November 3, 2005, a small portion of the left tibia was sent to the AFDIL, in Rockville, Maryland, for mtDNA analysis. Blood references from family members

of missing service members were obtained and compared to the data obtained from the left tibia. Exclusionary results, along with evidence obtained from the site, concluded that the missing individual was Air Cadet Leo Mustonen from Brainerd, Minnesota.

The views expressed herein are those of the authors and not necessarily those of the Armed Forces Institute of Pathology, the U.S. Army Surgeon General, nor the U.S. Department of Defense.

Identification, mtDNA Analysis, Frozen Remains

G66 Caddisfly Cases Assist Homicide Case: Determining a Postmortem Submersion Interval (PMSI) Using Aquatic Insects

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The goal of this presentation is to discuss a particular case study that exemplifies the importance of understanding aquatic insect biology to help determine a postmortem submersion interval (PMSI) in streams, rivers, and possibly lakes. This study demonstrates how certain aquatic insects, e.g., caddisflies (Order: Trichoptera, Family: Limnephilidae) can be useful in estimating the time period from a body is submerged to the point of discovery. The attendee will learn that some aspects of aquatic entomology can be useful in criminal investigations by learning how to incorporate life history aspects of aquatic insect biology to estimate a PMSI.

This presentation will impact the forensic community and/or humanity by demonstrating that there are aspects of aquatic entomology valuable to forensic investigations involving bodies recovered from aquatic systems. To date, very little research exists on the use of aquatic organisms to estimate a postmortem submersion interval; this particular case illustrates how aquatic insect evidence can augment traditional techniques used in criminal investigations to develop a PMSI time line.

The determination of a postmortem interval using entomological evidence collected from terrestrial crime scenes has been well documented. A review of the literature found that approximately 85% of studies pertained to terrestrial organisms, while only 15% pertained to aquatic organisms. This dichotomy can be explained simply because terrestrial insects have evolved to feed on carrion while aquatic insects have not. Therefore, because the biology of some terrestrial insects is intimately tied to decomposing animal flesh, where aquatic insect biology does not, this biological difference has facilitated the use of terrestrial insects in criminal investigations. Consequently, many times aquatic insect evidence is ignored from crime scenes in aqueous environments. Since remains are often found in aquatic environments, it is important that forensic scientists and law enforcement personnel visiting such crime scenes have an increased knowledge of the aquatic organisms that could potentially colonize human remains.

Although few indicators of time since death for remains found in aquatic ecosystems are comparable in precision to the insect indicators used in terrestrial cases, there are observations that can be useful in suggesting or ruling out an approximate PMSI. For example, the time intervals needed for certain growth phases of aquatic insects such as caddisflies that may attach themselves to the remains can be used to estimate a minimum PMSI. Approximately eight of the 13 orders of insects containing species with aquatic or semi-aquatic stages are likely to be associated with carrion or remains in aquatic habitats. The evolution of a vast array of physiological and behavioral adaptations in aquatic insects enables these organisms to inhabit virtually all bodies of water.

Portions of a body from an adult male were discovered in a south central Michigan stream. The body was dismembered and portions were recovered from plastic bags floating in the stream. Insects specimens collected from the plastic bags containing body parts consisted of one fly larva (Diptera) belonging to the family Muscidae, and caddisfly larvae (Trichoptera) belong to two families, the Limnephilidae or case-makers and the Hydropsychidae, net spinners. Because of case material type, size of mineral pieces used in the case, and the size of the stream from where they were collected, larvae belonging to the family Limnephilidae were separated into two different species, as well as placed in specific larval instars (or larval stage of development) which helped to age them. Based on the similarities of the behavior, life histories and occurrence of these two species throughout the year, two caddisfly species belonging to the genus *Pycnopsyche* were present, mainly the last developmental larval stage of *Pycnopsyche lepida* and *Pycnopsyche guttifer* were identified. Unique case-building behaviors of these Limnephilid caddisflies found on the remains were used to elucidate a PMSI range consistent with the disappearance of the victim. It is important for forensic investigators to understand that although some precision is lost in estimating a PMSI with aquatic insects, these organisms should not be ignored in gathering evidence from aquatic crime scenes, that in fact, they can provide valuable details in estimating a PMSI.

Aquatic Insects, Caddisflies, Postmortem Submersion Interval

G67 A Standardized Field Protocol for Experimentally Investigating Variability in Entomology-Based Postmortem Intervals Over Multiple Sites and Years: A Proposal

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After attending this presentation, attendees will gain understanding of the key factors that influence variability of entomology-based PMI estimates and the need for forensic entomologists to devise standardized field experiments at multiple sites over several years. Such a protocol will disentangle the combined and interactive effects of these key factors on carcass decay rates and carrion-arthropod colonization, development and succession.

This presentation will impact the forensic community and/or humanity by through the introduction of this collaborative framework and call for a standardized field protocol, the authors will provide the forensic science community several scientific examples, gleaned from the entomological literature, of the need to better understand spatio-temporal variability of entomology-based PMI estimates through the establishment of a small network of field sites.

A multi-site field protocol, modeled after the U.S. Long-Term Ecological Research Network, is proposed for investigating the major

biotic and abiotic factors that influence entomology-based postmortem intervals (PMI), i.e., the time period between insect colonization and body discovery. The study proposes that this goal can only be achieved by a multi-investigator group studying forensically-important (FI) arthropods year-round over several years. Investigators and sites will be chosen from a subset of active and willing researchers (with established track records) whose institutions bracket more latitudes than longitudes in order to reflect the widest range of climates and vegetation types.

The central features of this protocol, which the authors have embraced in their own research and training programs, include the use of pig carcasses as surrogate corpses, fixed sampling stations as mock crime scenes, comparative tests of different field methods, and the integration of photographic, climatic, and arthropod records. The domestic pig (*Sus scrofa* Linnaeus) (of roughly 23-27 kg starting weight) closely resembles a human in its fat distribution, chest cavity, lack of heavy fur, and omnivorous diet. Advantages to using pigs include ease of procurement, reasonable cost, and a low propensity to incite public objection. The pig-as-surrogate claim was recently validated in field trials conducted inside the Forensic Anthropology Center (formerly ARF) at the University of Tennessee, Knoxville, TN, using simultaneously placed human and porcine subjects studied over a 35-day summer period. In that study, exceptionally high overlap in arthropod abundances (>99%) was reported from three subjects (one human, two pigs), indicating that only a few very rare FI taxa were associated with one subject or the other.

Within each site, the initial study design will feature replicated pig carcasses representing the “background” condition (i.e., surface-exposed, unclothed, and vertebrate unscavenged) against which other replicated treatments could be compared in the future (e.g., buried, burned, submerged, clothed, and/or vertebrate scavenged remains). Recent research has shown that when different sampling methods are used to inventory the carrion-arthropod fauna (i.e., aerial nets, hand collections, pitfall traps, sticky traps), results are often species-selective leading to catches of variable species composition which have the potential for affecting PMI estimates. Many other studies have established that carrion-arthropod succession and carcass decay rates are affected by season, temperature, elevation, exposure mode (e.g., buried, burned, submersed, wrapped), presence/absence of predators, and other factors.

Through this protocol, it is hoped to achieve a better understanding of variability and uncertainty in PMI estimates by holding constant both investigator error and exposure conditions. To further this goal this study will work to disentangle the combined and interactive effects of climate, season, and geography on carcass decay rates and arthropod colonization, development, succession, and species composition. To further reduce inter-investigator error, the study will require that each researcher channel his/her voucher specimens to the same taxonomic specialists to insure uniformity and accuracy of identifications across sites. Statistical analysis will focus on testing whether the order and timing of different species of colonizing insects used in both development and succession-based PMI estimates are comparable (i.e., repeatable) across different sites, seasons, and years. Given the critical need to separate pattern from “noise” in forensic entomology and to accurately and precisely estimate time-of-death, which the Law requires to be ascertained, the need for a standardized field protocol that can function at multiple sites for several years becomes clear.

Through the introduction of this collaborative framework and call for a standardized field protocol, the authors will provide the forensic science community several scientific examples, gleaned from the entomological literature, for the need to better understand spatio-temporal variability of entomology-based PMI estimates through the establishment of a small

network of field sites.

Forensic Entomology, Postmortem Interval, Field Protocols

G68 Characteristics of Fatal All Terrain Vehicle (ATV) Accidents

Michele Eichenmiller, MS, James A. Kaplan, MD*, David J. Clay, BA, Myron A. Gebhardt, MS, Brandon Lewis, BS, Nabila A. Haikal, MD, James C. Kraner, PhD, Office of the Chief Medical Examiner, 619 Virginia Street West, Charleston, WV 25302

After attending this presentation, attendees will learn of particular concerns to be considered when investigating fatal ATV accidents.

This presentation will impact the forensic community and/or humanity by focusing attention on the circumstances of fatal All Terrain Vehicle (ATV) accidents, particularly the role of alcohol impairment.

The goal of this presentation is to highlight some of the forensically relevant circumstances surrounding deaths that result from ATV accidents. Emphasizing the factors that are common to these cases will enhance the attendee's attention to pertinent issues to be considered when investigating ATV related deaths.

An all-terrain vehicle or "ATV" is defined as any vehicle fifty-two inches or less in width, having an unladen weight of 800 pounds or less, traveling on three or more low pressure tires with a seat designed to be straddled by the rider, intended for, or capable of travel over unimproved terrain. Using national data from 2002-2004, West Virginia leads the nation with an annual average of 1.7 fatalities per 100,000 people; followed by Kentucky at 0.85. The national average for the same period is 0.17 deaths per 100,000 citizens.

The West Virginia Office of the Chief Medical Examiner investigated the fatalities reviewed in this report. Biological samples were obtained from each of the cases during either internal autopsy or external examination of the body. Over a three-year period (2003-2005), a total of 99 fatal ATV-related accidents occurred in West Virginia. Of the fatalities reviewed, 85 were male and 14 were female. The decedents ranged from 7-80 years of age, with 36 being the average age. Overall, October was the month with the highest incidence (14 cases), followed by May and July with 13 fatalities occurring during each. Toxicological testing included blood alcohol analysis by direct injection GC-FID using *t*-butanol as an internal standard. Samples were also tested for drugs of abuse. However, only alcohol findings are included in this presentation. Other significant observations include the following:

- Fifty-eight percent of the accidents occurred on unpaved roads, with 28% on paved roads. The road surface was not specified in the records available for review in the remaining cases.
- Eighty-four of the fatalities were drivers, while ten were passengers. The position of the decedent was not ascertained in five of the deaths.
- There were ten multi-vehicle and 75 single-vehicle accidents. In fourteen collisions, the number of vehicles involved was not specified.
- Only thirteen individuals were wearing a helmet whereas 51 were not; and of the latter, seven were under the age of 18.
- Excessive speed was documented in the investigative reports of 14 fatalities and was not named as a factor or unknown in the remaining 85 cases.
- Forty-nine percent of the fatalities had blood alcohol concentrations exceeding 0.08%.
- The average blood alcohol concentration was $0.19\% \pm 0.09\%$.

Through the first seven months of 2006, 39 ATV-related deaths had already occurred in West Virginia, underscoring the need for addressing the problem of ATV safety by state government.

In conclusion, high blood alcohol concentration is a frequent factor in fatal ATV accidents. It is also important to note that the generally steep terrain of West Virginia is an additional concern when operating vehicles with a high center of gravity, such as an ATV. Other ATV-specific accident factors obtained from police and injury-prevention sources will also be presented.

ATV, Fatality, Accident

G69 Using Ninhydrin to Detect Grave Soil

David O. Carter, PhD*, Department of Entomology, University of Nebraska-Lincoln, 202 Plant Industry Building, Lincoln, NE 68583-0816; David Yellowlees, PhD, School of Pharmacy and Molecular Sciences, James Cook University, Townsville, QLD 4811, Australia; and Mark Tibbett, PhD, Centre for Land Rehabilitation, School of Earth and Geographical Sciences, University of Western Australia, Crawley, WA 6009, Australia

After attending this presentation, attendees will understand fundamental effects of cadaver decomposition on associated soil (grave soil) and the methodology required to analyze grave soils for the presence of ninhydrin-reactive nitrogen.

This presentation will impact the forensic community and/or humanity by providing a method to rapidly locate clandestine graves and cadaver decomposition sites.

After this presentation, attendees will understand fundamental effects of cadaver decomposition on associated soil (grave soil) and the methodology required to analyze grave soils for the presence of ninhydrin-reactive nitrogen. This presentation will impact the forensic community by providing a method to rapidly locate clandestine graves and cadaver decomposition sites.

Some death investigations commence without knowledge of the location of a body and/or decomposition site. In these cases it is necessary to locate the remains or the site where the body decomposed prior to relocation. Ideally, the location of these sites would be rapid and require little destruction of the scene, such as that achieved with cadaver dogs. However, few options remain if cadaver dogs are unavailable or prove unsuccessful.

Ninhydrin is a compound that is readily available to most investigative agencies, as it can be used to locate latent fingerprints. This use relies on the color change that occurs when ninhydrin reacts with protein-, peptide-, amino-, and ammonium-nitrogen (collectively known as ninhydrin-reactive nitrogen: NRN) left on a surface contacted by skin. Similarly, the decomposition of an organic resource results in the release of NRN into the soil. Considering that a cadaver can comprise as much as 3% nitrogen, there is great potential for NRN to be detected in grave soils. As a consequence, this study hypothesizes that the decomposition of a body would result in a significant increase in NRN in soil.

A field experiment was conducted at two disparate field sites during the dry season (March 2003). Site 1 was comprised of a loamy sand soil (84% sand, 11.1% silt, 4.9% clay) and was located in Yabulu, Queensland, Australia. Site 1 receives an average rainfall of 140 mm during the dry season (March-October) and average maximum/minimum temperature equals 22.9 °C/16.7 °C. Site 2 was comprised of a sandy soil (97.7% sand, 1.3% silt, 1% clay) and was located in Pallarenda, Queensland, Australia. On average, site 2 receives 120 mm of rainfall during the dry season and the average maximum/minimum temperature is 26.9 °C/16.4 °C. Grasses with scattered trees dominated the resulting vegetation at the two sites, as is typical of a tropical savanna ecosystem. Juvenile rat (*Rattus rattus*: ~18 g) cadavers were buried (2.5 cm) in the centre of a 2 m² plot. Grave soil was collected at 7, 14, 21, and 28 days following burial.

To measure NRN, 2 g soil (dry weight) was amended with 8 ml KCl (2 M) and shaken (150 rpm) for 30 minutes. Following shaking, the solution was filtered through a filter paper (#42) into a culture tube. To 1 ml of filtrate, 0.5 ml ninhydrin reagent [0.8 g ninhydrin, 0.12 g hydrindantin, 30 ml dimethyl sulfoxide, 10 ml lithium acetate] was added, mixed, and incubated at 100 °C for 25 minutes. The reaction was stopped with 10 ml 50% ethanol-water (v/v) and absorbance was read at 570 nm. The concentration of NRN was calculated against a leucine standard. To make leucine standard, 0.469 g leucine was dissolved into 1 l distilled water. This contained 50 mcg nitrogen ml⁻¹. Separate 100 ml volumetric flasks were amended with 0, 5, 10, 15, 20 and 30 ml leucine solution, 50 ml of 4 M KCl, and water to make up to 100 ml. These standards contained 0, 250, 500, 750, 1000 and 1500 mcg nitrogen.

Cadaver burial resulted in a 4-6 fold increase in the concentration of NRN in grave soil. This increase was observed within seven days of burial and remained constant until the end of the experiment (day 28), by which time the cadaver had been skeletonized for a minimum of 14 days. This rapid and stable increase in NRN has great potential to become a standard investigative tool, considering that the analysis of NRN in grave soil can be conducted in less than one hour.

Forensic Taphonomy, Decomposition, Nitrogen

G70 Insects and Time Since Death: What Do We Really Estimate?

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After attending this presentation, attendees will gain an understanding of some of the limitations and constraints of time of death estimates based on entomological evidence

This presentation will impact the forensic community and/or humanity by making attendees aware of the problems and constraints associated with time since death estimates based on entomological evidence, the participants will be better able to evaluate the significance of these estimates to their investigations.

Forensic entomology is a powerful tool for use in the estimation of the minimum period of time since death in many cases. There are, however, certain constraints in its application that must be kept in mind. First, what is provided is primarily an estimate of the period of insect activity on the body, rather than an estimate of the actual period of time since death. While these periods are frequently quite similar and the estimate provided is close to the actual time since death, they are not identical. There also exist a number of confounding factors beyond the control of the entomologist and/or crime scene personnel that will further serve to reduce the similarity between the estimate and the actual postmortem interval. These include: concealment of the body, incomplete collection of relevant materials by scene personnel, presence of chemicals on or around remains, seasonal and geographic variations in insect distribution, microclimatic factors, and lack of common sense. Additional problems lie in approaches to interpretations of data, often resulting in estimates produced that can not be supported by the current state of the sciences involved.

Postmortem Interval, Insects, Entomology

G71 Dying of the Cold in a Warm Climate - Hypothermia Deaths in Sydney, Australia

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The goal of this presentation is to describe the features of hypothermia related deaths in Sydney, Australia, a geographic location generally viewed as having a temperate to hot climate.

This presentation will impact the forensic community and/or humanity by highlighting the dangers of hypothermia in the elderly, even in temperate climates. Attendees will be informed of the social circumstances, the death scene and pathological findings at autopsy in this series of cases.

Death due to hypothermia is well known as a significant public health problem in cold climates, affecting predominantly homeless people, drug dependent persons, and the elderly. Hypothermia is generally considered very rare in more temperate climates and there is a general lack of awareness of the problem by both the medical fraternity and the general public. This study examines the problem of fatal hypothermia in Sydney Australia, a city with a reputation of having a year round temperate to hot climate.

There were 24 cases of fatal hypothermia in a five-year period between January 2001 and December 2005. For the purposes of this study, the diagnosis of hypothermia was made by either a temperature measurement at hospital (17%), suggestive autopsy findings (33%), a suggestive history (4%), or a combination of autopsy findings and a suggestive history (46%). The majority of the deaths occurred in winter (46%) as expected, whilst equal numbers occurred in the seasons on either side of winter - spring (25%) and fall (25%). Despite generally hot summer temperatures, one death occurred during summer. This person had become lost in bushland and was found in a state of extreme dehydration.

The mean age was 76 years (range 56 – 92), with a female predominance (63%). Risk factors for hypothermia were identified in 58%, and these included alcoholism mental illness (schizophrenia, bipolar disorder) and developmental delay. All but two decedents lived alone. Nine decedents were underweight (body mass index < 20 kg/m²).

Nineteen cases (79%) were found in a building, a house, apartment, or other premises. Of those, 46% were dead at the scene, while the remainder died either on the way to or in hospital. In the remaining five cases, the decedent was found outside. Three in this group were dead at the scene, while two died subsequently in hospital. This indicates that despite rewarming and supportive care, hypothermia past a certain point is irreversible and fatal.

Four decedents were found naked, four were dressed in minimal amounts of clothing and the decedent was adequately dressed in a further three cases. There was evidence of paradoxical undressing in seven cases. In the remaining six cases, the presence or absence of clothing was not given.

Pathological findings in fatal cases of hypothermia are generally considered non-specific. Gastric erosions were found in 79%. There was one case with acute pancreatitis, and a single case with rhabdomyolysis. The characteristic cutaneous lesions in hypothermia, reddening and abrasion over the large joints of the limbs were present in 16 (75%) cases. In four cases (17%), there were no autopsy findings to suggest hypothermia, although either hospital or environmental features strongly supported the diagnosis. Other significant autopsy findings included atherosclerotic cardiovascular disease (50%), pneumonia (17%), pulmonary congestion and edema (17%), chronic airways limitation (13%) and single cases of glioblastoma multiforme and metastatic bowel cancer. With the exception of two cases where only a raised blood alcohol was detected, all cases had significant pre-existing natural disease processes. Toxicology was performed in 18 cases – alcohol was detected in four cases, and other psychotropic agents were present in four deaths. No illicit drugs were detected.

This study highlights a significant public health problem that is not limited to cold climates. There is little awareness of the hazards of hypothermia in the elderly in Australia and probably other temperate parts of the world. Life-threatening hypothermia does not occur at any one particular temperature, as other factors such as wind movement, clothing, dampness of the environment, and vulnerability of the individual all play a role. Forensic pathologists and other death investigators who have the good fortune of living in warm climates need to remain vigilant of this condition, and not misattribute the death to natural disease processes such as atherosclerotic cardiovascular disease or pneumonia.

Autopsy Pathology, Hypothermia, Environmental Medicine

G72 The Postmortem Picnic

Kathryn Haden-Pinneri, MD, Mary Lynn Anzalone, MD, and Luis A. Sanchez, MD, Office of the Medical Examiner of Harris County, Joseph A. Jachimczyk Forensic Center, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will understand a potentially confusing postmortem artifact caused by the Red Imported Fire Ant (RIFA) and stress the importance of good photographic scene documentation.

This presentation will impact the forensic community and/or humanity by educating forensic scientists about alterations in wounds caused by *Solenopsis invicta*, the Red Imported Fire Ant, which may affect wound interpretation.

Postmortem alteration of wounds by insects is a fairly common phenomenon, especially in decomposed bodies where maggots are frequently encountered. The destruction they produce can be significant, even to the point of complete obliteration of the wound and the underlying wound track. Without damage to the skeletal elements, the trauma may not be discernible. Alterations of wounds in the “fresh” state are not as common; however it is being seen with increasing frequency in the Southern United States, where fire ants have invaded.

Solenopsis invicta (*S. wagneri*), the Red Imported Fire Ant (RIFA), has infested large parts of the United States, concentrating mainly in the warmer Southern region. States from California to Maryland have documented their presence and the destruction they cause. Lacking predators and parasites, these ants have become a major pest, destroying plants, crops, trees, and even small animals. They are also attracted to electrical currents and subsequently damage electrical boxes, air conditioners and other equipment.

First introduced into the U.S. from its native South America, the RIFA arrived in cargo from Brazil at the port of Mobile, AL in the 1930s. This species has spread rapidly throughout the Southeastern United States and has recently been identified in Australia, the Philippines, Taiwan, and China.

Fire ants are omnivores, feeding on almost any plant or animal. Other insects are their preferred food. Humans become affected by the RIFA when it bites and stings. In response to vibration or movement, RIFAs react quickly and aggressively to disturbances of their colony or mound. A single ant will sting repeatedly, even when out of venom. The RIFA bites with its mandibles to attach itself to the skin, and then it stings with its abdomen, injecting toxic venom. A pustule forms in 24-48 hours, which may get secondarily infected. Some individuals are allergic to the venom, and anaphylaxis may ensue.

For forensic pathologists, RIFAs are creating problems by their rapid appearance on bodies found outdoors. Within minutes, 10-20 ants will arrive at the body, and many more will come after that. Rather than biting and stinging in an aggressive manner, the RIFA just bites, gaining sustenance from the body instead of injecting venom. In contrast to maggots, which prefer open wounds, moist mucous membranes and dark environments, RIFAs will readily eat intact exposed skin. They tend to concentrate at clothing/skin interfaces and prefer the outer surface of the body, rarely entering the body cavities or altering the wound tracks.

Increasingly, RIFAs are being encountered in open wounds, and the changes they leave behind can be troublesome. In general, postmortem artifacts caused by insects are easily distinguished from antemortem trauma. When a wound is involved, however, the changes are not as straightforward. The yellowing, seen with postmortem insect activity is usually lacking or is camouflaged by the actual wound characteristics.

Firearm wounds, in particular, can have a very puzzling appearance when altered by RIFAs. If only a few bites occur around the wound, it may be mistaken for stippling, thereby altering the interpretation of range of fire. On the other hand, if a large number of RIFAs are present and they have been there long enough, determination of entrance versus exit may be completely obscured.

Scene photographs are key in order to verify or deny the presence of RIFA activity. A small number of RIFAs will usually get transported with the body and/or in the body bag. Without scene photographs to review, you may not realize the extent of their involvement in wound alteration. In one case, the edges of a gunshot wound were very irregular, simulating an atypical entrance or possible intermediary target. Scattered areas of postmortem insect activity elsewhere on the body indicated the presence of RIFAs; however, it wasn't until the scene photos were reviewed that it was apparent to what extent they had altered the gunshot wound. In one photo, RIFAs are seen completely filling the wound, something typically associated with maggots, not ants. This large concentration of RIFAs imparted an atypical appearance to the gunshot wound.

In addition to the many other variables that cause alterations of wounds in the postmortem setting, changes induced by RIFAs must be considered, particularly in bodies found outdoors. RIFAs pose an additional hazard at the time of autopsy. Care must be taken when manipulating bodies or clothing containing RIFAs because the ants will act aggressively, biting and stinging those that have disturbed them, possibly inciting an allergic reaction in susceptible individuals. As RIFAs continue to invade the United States, more and more forensic investigators will be left to interpret the trauma they leave behind.

Solenopsis Invicta, Fire Ant, Postmortem Artifact

G73 Applying Statistical Principles to the Entomological Estimation of Postmortem Interval

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After attending this presentation, attendees will understand how four statistical principles apply to the estimation of ambient temperature necessary to enable the entomological estimation of postmortem interval. Specifically, attendees will understand how estimate precision, random variation, sufficient sample size and sampling breadth, and the choice of estimation model (e.g., linear, non-linear) should be considered and taken into account when postmortem interval ambient temperatures are estimated.

This presentation will impact the forensic community and/or humanity by highlighting how the consideration of four statistical principles can inform the estimation, accuracy, and precision of the postmortem interval, as made through entomological techniques.

After attending this presentation, attendees will understand how four statistical principles apply to the estimation of ambient temperature, which is required for estimation of postmortem interval using entomological evidence. Specifically, attendees will understand how estimate precision, random variation, sufficient sample size and sampling breadth, and the choice of estimation model (e.g., linear, non-linear) should be considered when postmortem interval ambient temperatures are estimated.

This presentation will impact the forensic sciences community by highlighting how the consideration of four statistical principles can inform the estimation, accuracy, and precision of the postmortem interval, as made through entomological techniques.

By examining the type and developmental stage of insects found on remains, entomological techniques can provide an estimation of the time since death or the postmortem interval. Insect development is highly dependent on ambient temperature, therefore, estimate using insect evidence require determination of the temperatures that the remains were exposed to following death. While these exposure temperatures can be

readily determined in many cases, in others, when no temperature recordings are available, they must be indirectly estimated, often by examining the relationship between the temperatures at the site where the remains were found and those recorded at a nearby weather station. This relationship can be determined by taking temperature recordings at the site where the remains were found for an extended period of time following their recovery and comparing these with the temperatures recorded over the same period of time at the nearby weather station. Using the statistical techniques of regression, the relationship between these two measures can then be defined by a suitable mathematical equation that, for a given weather station temperature, can provide an estimate of the corresponding temperature at the site where the remains were found.

However, because these temperature estimations are obtained by the mathematical regression modeling of the relationship between two sets of measured values, the application of four statistical principles can enhance the accuracy and precision of the estimated temperatures. First, because both sets of temperature measures are affected by random variation, the resulting regression model will be inherently imprecise—that is, single unique temperature values cannot be precisely predicted but, more realistically, a range of compatible temperature values can be determined. This range of compatible values is identified through the calculation of the “confidence interval for an observation” [1: 275-278] for each temperature estimated.

Second, because the precision of any given model will improve (i.e., the range of compatible values will narrow) according to the number of pairs of measurements available for model development, a sufficient number of temperature pairs should be included in the data collection used to develop the model. Third, it is also important to ensure that a sufficient number of comparative temperature pairs are collected over the full range of expected values (i.e., the range of temperatures that the remains were estimated to be exposed to prior to being found). If this is not done then ‘outlier’ temperatures will need to be estimated by extrapolating the model beyond the range of values that were used for its development. Because such extrapolated estimates assume that the relationship between the two sets of temperatures is the same beyond the measured values as it is within the measured range, erroneous temperature estimates will result when this assumption is not met. Of course, ensuring that the assumption applies in a given circumstance requires that actual temperature measures be collected across a sufficiently broad range of values.

Fourth, while a straight line (i.e., linear) relationship is often expected to best model the relationship between two measures, this is not always the case. As such, to enhance the accuracy of the temperature estimates, the type of relationship between the two sets of temperature measures should be appropriately studied so that the applicable mathematical model (i.e., linear or one of the many non-linear possibilities) for each set of temperature data can be accurately determined. In fact, it is possible that different models may be required for different parts of the same set of data (e.g., day versus night). For example, because of the characteristics of a setting where remains were found, temperatures at that site might be found to be generally higher during the day, but lower at night (in comparison to the corresponding weather station temperatures), thus necessitating the development of two distinct models to be used to estimate the applicable temperatures, according to the time of day.

During the presentation, examples illustrating each of these statistical principles, and their applicability and impact upon the entomological estimation of postmortem interval will be demonstrated and discussed.

Reference:

¹ Glantz SA. *Primer of Biostatistics* (Sixth Edition). New York, NY: McGraw-Hill, 2005.

Postmortem Interval, Statistics, Entomology

G74 The Validation of Gene Expression as a Means of Predicting the Age of the Blow Fly *Lucilia sericata*

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After attending this presentation, attendees will understand the use of gene expression in determining the age of forensically useful blow flies.

This presentation will impact the forensic community and/or humanity by helping the forensic community understand how to use gene expression and statistical analyses to better address the requirements of *Daubert* as it pertains to forensic entomology.

Forensic entomology is an established field, with a relatively good track record of predicting a postmortem interval (PMI) through an understanding of blow fly development. However, in the context of *Daubert*, all of the forensic sciences will be expected to provide techniques that have been adequately tested, have laboratory standard operating procedures (SOPs), have undergone publication in the peer-reviewed literature, are accepted by the relevant scientific community, and have known potential error rates. Though forensic entomology can meet most of these criteria, the field will likely be required to establish SOPs and provide information as to error rates and the precision of its methods.

In addition to not yet fully meeting *Daubert* requirements, blow fly based PMI estimates suffer from increasing error as the animal develops (Wells and Lamotte 1995). This stems from the fact that the durations of subsequent developmental stages increase, and the body size traits used by entomologists (larval length or weight) that help refine age estimates in the feeding stages become far less useful in the later stages of immature development. Thus, other characteristics that predictably change during these stages are potential sources of information that could be valuable to investigators attempting to age flies. Gene expression profiles are known to vary significantly throughout the development of all animals, and have been studied extensively in the dipteran *Drosophila melanogaster* (e.g., Arbeitman et al. 2002). To understand how gene expression might be utilized for more accurately aging a forensically useful blow fly, a gene expression profile data set for nine developmentally variable genes was created for the immature life cycle of ~700 individual *Lucilia sericata*. Three regional strains of flies were grown under controlled laboratory conditions and regularly sampled for both size and gene expression levels, creating a high-resolution developmental profile of these cohorts.

Following this, genetic profiles were used in conjunction with developmental stage and body size data to estimate the age of individual blow flies. However, body size and gene expression levels are not easily explained by a simple mathematical function (they are non-parametric) and statistical endeavors that can help investigators (and triers of fact) understand such multivariate and non-linear data must be employed to make predictions of age. To this end, statistical models of developmental age in terms of genetic and phenotypic profiles have been produced. The two most promising forms are principle component analysis and generalized additive models. The former has been used in other forensic sciences to make predictions of class evidence and may be useful with entomological data. With generalized additive models, it is possible to define the percent of development explained by the data, and to deduce the usefulness of different models (and variables within models) through a comparison of generalized cross validation (GCV) scores (Wood 2006). Currently, predictions of age incorporating standard data and gene expression can describe up to 97% of the variation in development, which is an increase of ~10% compared to using developmental stage and body size alone.

However, no mathematical model is useful based solely on its theoretical ability to predict age, thus the models need to be validated on different data sets. To accomplish this, a blind study was conducted with

flies grown under both experimental (in the laboratory using the same conditions as the original experiment) and natural (out of doors) environments. Gene expression and body size profiles of the juvenile flies collected were used to predict the age of the individuals employing the models generated from the aforementioned data set. The validation of the age models and their importance in helping the field of forensic entomology increase precision and meet the requirements of *Daubert* will be discussed.

Forensic Entomology, Postmortem Interval, Generalized Additive Model

G75 Have I Eaten Here Before? Considering Multigenerational Colonization of Remains by Blow Flies

Timothy E. Huntington, MS*, and Leon G. Higley, PhD, University of Nebraska, Department of Entomology, 202 Plant Industry Building, Lincoln, NE 68583

After attending this presentation, attendees will understand that there is little potential for multiple generations of blow flies arising from the same corpse.

This presentation will impact the forensic community and/or humanity by demonstrating a substrate limitation to blow fly colonization of decomposing remains.

Forensic (or medicocriminal) entomology, the use of arthropods in legal investigations, is most frequently employed to estimate the postmortem interval (PMI) of victims of violent crimes or suspicious deaths. The most commonly used method of PMI estimation employs temperature-dependent developmental rates of blow fly larvae (Diptera: Calliphoridae). Retrospective scene temperatures, those temperatures that the insects experienced during development, are used in combination with known developmental rates of the species involved to estimate the age of the insects, which often correspond closely with the time of death of the victim.

One key element entomological analysis is the use of the oldest insects associated with the body, as these represent the closest estimate of the minimum time since death. This facet of forensic entomology consequently leads to questions by investigators and attorneys regarding the potential for multiple generations of blow flies arising from the same corpse. While blow flies continue to be attracted to the carrion well into the later stages of decomposition, the carcass is no longer attractive as an oviposition medium after some point, and it is widely held that the maggots which fed on a set of remains will not normally eclose as adults and oviposit on the same body. Flies in abnormal conditions, however, have been known to alter their behavior as a response to their circumstances. The goal of this study was to investigate whether adult blow flies eclosing into a situation where there is no carrion source other than their larval host would oviposit on this carcass or die without reproducing.

Six freshly killed pig (*Sus scrofa* L.) cadavers (~53 kg) were placed on the soil surface and left undisturbed for approximately 45 hours (75 ADD-B0) to allow for extensive insect colonization. After this time, Lumite® (18 x 14 mesh) exclusion cages (6 ft³) were erected over each pig. After placement of the cage, adult blow flies were physically killed or removed from the cage. Subsequent maggot development into adult blow flies occurred within each cage, resulting in high populations of adult flies that represented the first generation of fly development on the cadaver. Following the emergence of adult flies within each cage, a 'choice'/'no choice' study was conducted by placing a freshly killed pig (~47 kg) in three of the cages and observing for colonization of each carcass.

In this study, each of the fresh pig cadavers in the 'choice' portion of the experiment were colonized readily by blow flies, but none of the

decomposed remains (in either the 'choice' or 'no choice' scenarios) were colonized. This result is not unexpected, but confirms the conventionally held understanding of a single generation of blow flies emerging from a single corpse, even under extenuating circumstances. The fact that blow flies under these conditions die without reproducing indicates the unsuitable nature of a body that has undergone advanced decomposition as larval substrate.

Forensic Entomology, Decomposition, Taphonomy

G76 The Investigation of Animal Tissue as an Analogue for Human Tissue in Decomposition Studies in Soil

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After attending this presentation, attendees will understand the chemical process of decomposition, the compounds released during the decomposition of muscle tissue of different species, and their interaction with the soil environment. The aim of this presentation is to compare the use of animal tissue as an accepted model for human tissue in decomposition trials.

This presentation will impact the forensic community and/or humanity by showing direct comparisons between the decomposition chemistry of human and various animal tissues in a soil environment. The identification of both similarities and differences between the different tissue types will help identify the best animal analogue for future decomposition studies.

Pig (*Sus scrofa*) carcasses are currently accepted as the closest model to human decomposition due to their physiological similarities to humans. For this reason they are commonly used in a range of decomposition studies involving microbial activity and entomology. However from a chemical perspective there are limitations with this model due to variations in the decomposition compounds produced by humans and animals. Furthermore, the behavior of these compounds in soil is unknown with respect to the subsequent nutrient dynamics. The current study was therefore conducted to investigate the chemical decomposition of skeletal muscle tissue in soil and to compare similarities and/or differences between human and animal tissue. The results will assist in determining the most useful animal model in chemical decomposition studies. The research may benefit forensic investigations involving decomposed remains whereby the species determination is in question.

A laboratory incubation method was used to monitor chemical changes during decomposition. The soil in each microcosm was a sand texture adjusted to 50% water holding capacity to provide optimal conditions for microbial activity. Cuboid pieces of skeletal muscle tissue from four different species, namely porcine, bovine, ovine and human, were interred at 1 cm depth in the soil and incubated at 25°C for 37 days. Carbon dioxide evolution was used as an index of soil microbial activity. Aerobic conditions were maintained by opening the microcosms daily to replace oxygen depleted air from the container. The microcosms were destructively harvested at periods of 2, 4, 6, 8, 12, 16, 23, 30 and 37 days. Any remaining skeletal muscle tissue was removed, weighed, and dried to ascertain mass loss. The soil immediately surrounding the site of muscle tissue decomposition (detritosphere) was collected and analysed. The mineralization of nutrients was monitored by analyzing inorganic molecules within the soil using colorimetric methods for ammonium,

nitrate and phosphate, and atomic absorption spectroscopy for potassium levels. The release of long chain fatty acids into the soil was also monitored using GC-MS.

Results have demonstrated that for all skeletal muscle tissues there is an observed increase in pH before a decrease back to the starting pH measured prior to muscle tissue interment. Electrical conductivity also increases for all different types of skeletal muscle tissue. Further results from organic and inorganic chemical analyses will be discussed in the presentation.

Animal models are commonly used for decomposition studies due to restrictions on the use of human cadavers. The results from this study will impact the forensic community by showing direct comparisons between the decomposition chemistry of human and various animal tissues in a soil environment. The identification of both similarities and differences between the different tissue types will help identify the best animal analogue for future decomposition studies.

Animal Tissue, Human Models, Decomposition

G77 'Ndrangheta' Homicide (Executions)!

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After attending this presentation, attendees will learn about 'Ndrangheta,' one of the famous "four mafias" a criminal organization from the southern part of Italy. A unique case of 'ndrangheta'-related homicide/double execution is presented. A detailed scene investigation and a complete postmortem examination were performed; the surface aspects of gunshot wounds were also analyzed by means of confocal laser scanning microscopy.

This presentation will impact the forensic community and/or humanity by demonstrating the rarity of the modalities of this execution makes it peculiar and a complete pathologic investigation (death scene investigation, autopsy performing, and toxicological screening) is strongly recommended to completely investigate this type of homicide.

This unique case of double simultaneous "'ndrangheta"-related homicide, or execution was discovered in the Tuscan countryside. In the morning of April 10, a farmer noted the presence of bloodstains near the road on his property. The bloodstain course ended in a wooded area where a gun case was detected. He immediately alerted the authorities. An unusual arrangement of the leaves next to the road caught the attention of those searching the area. A few centimeters under these leaves and soil, hands and feet surfaced; at the end of excavations, 160 cm underground, two lifeless bodies were present. They were found kneeling, beside each other. The two bodies were covered with burnt lime, which was cautiously removed. They were dressed only underpants and wore a pair of gloves. Clothes belonging to the deceased were found next to the bodies. Core temperature of the remains, measured by means of bulb thermometer, was 14°C. The external temperature was 17°C. Rigor mortis was partially present and livor mortis was represented by fixed reddish-purple coloration localized on anterior part of the bodies. At external examination the caustic effect of burnt lime on the face and the trunk was observed. A round wound on the left occipital region was detected on each body. A second round wound on the right dorsal region was observed in one of the deceased. Forty-eight hours after discovery, a complete autopsy was performed. A total body CT study confirmed in one case the presence of a metallic foreign body in the first cervical segment while in the second case foreign metallic bodies were observed in the right orbital region and at the mandibular angle. Postmortem examination of the spinal cord was performed according to the Adam's technique and the deformed bullets

were recovered. A complete histological study was performed. Cutaneous gunshot wounds were also studied by means of confocal laser scanning microscopy. Few days after the examination, a positive identification was made by fingerprint comparison. The victims were two brothers belonging to the criminal association 'ndrangheta' under probation in Tuscan countryside. It is well known all over the world of the existence of the "four Italian mafias" that are referred to the "Cosa Nostra" in Sicily, the "Camorra" in Campania, the "Sacra Corona Unita" in Puglia and the 'Ndrangheta' in Calabria. The last one is estimated to be Italy's most powerful organized crime association, surpassing the Sicilian Mafia. Their moneymaking schemes include racketeering, extortion, loan sharking, illegal immigration, money laundering, cigarette smuggling, and arms and narcotic trafficking. In homicides committed by criminal organization the method employed as well as the positioning of the body follow a macabre ritual laden with significance and intending to be a warning to others who interfere with the activities of these organizations.

Ndrangheta Homicide Execution, Burnt Lime, Confocal Microscopy

G78 Pig-Mentation: Postmortem Iris Color Change in the Eyes of *Sus Scrofa*

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After attending this presentation, attendees will learn that iris color of a deceased individual is not reliable for identification, and will have an appreciation of the implications of this phenomenon within the context of victim identification, particularly in mass fatality incidents.

This presentation will impact the forensic community and/or humanity by demonstrating the protocol for victim description, particularly in mass fatality incidents, should be modified in order to account for the taphonomic phenomenon of eye color change.

Eye color is one of the physical characteristics recorded in a missing person report and in a victim identification report. Software programs are employed, by law enforcement and disaster management agencies, to compare the two sets of data, searching for potential matches and eliminating individuals if the data are inconsistent.

A thorough review of the literature revealed that postmortem iris color change is mentioned in only two forensic pathology texts, by the same author. A study on the preservation of contact lenses using the eyes of *Sus scrofa* (domestic pig) also mentions the phenomenon of blue eyes changing to brown after death.

While experienced forensic pathologists should be familiar with the phenomenon of postmortem iris color change, it is not common knowledge among death investigators. Victim identification forms and disaster victim identification software currently in use in the United Kingdom, Canada and internationally contain a field for eye color. Moreover, recording eye color is standard routine in the external examination in an autopsy.

In order to determine whether Knight's references (2004 and 1997) are anecdotal and/or whether Jackson (2001) observed an anomaly, a controlled experiment of postmortem changes to isolated *Sus scrofa* eyes was carried out. The eyes (n=137) were observed for three days postmortem at three different temperatures. In addition, a *Sus scrofa* head with *heterochromia iridium* (two different colored eyes) was obtained in order to observe decompositional changes of eyes *in situ*.

All isolated blue eyes in the experiment, at room temperature and higher, changed to brown/black within 48 hours. The *in situ* blue eye, at room temperature, turned brown/black within 72 hours. In fact, the *in situ*

blue eye was indistinguishable from the *in situ* brown eye, and the change occurred prior to decomposition of the eye itself.

Blue eyes kept at a cool temperature exhibited signs of iris color change, but all of the eyes were still recognizably blue after 72 hours.

Drying of the sclerae in isolated eyes also occurred, the result being that the entire globe turned black concomitantly with the iris color. The sclerae of the *in situ* eyes with open lids, however, remained white and fresh-looking, and the blue eye changed to brown/black within 72 hours.

The possible role of the vitreous humour, which also turned black postmortem, is explored. The quantity of free melanin granules in the vitreous increases with postmortem interval. This is likely a result of the degradation of melanocytes in the retinal and choroids layers of the posterior chamber, in a process driven by autolysis. Further histological studies are required, including quantified melanin granule counts of vitreous humor samples using scanning electron microscopy.

Most importantly, further studies are required on human eyes to explore the reliability of this phenomenon and the conditions driving it. If postmortem iris color change occurs consistently in humans, then this taphonomic artifact will have to be taken into account when recording eye color in victim identification reports. This is particularly relevant in cases of mass fatalities, when victims may be exposed to the elements for up to several days, and a discrepancy such as eye color in antemortem and postmortem data may delay identification when processed by disaster victim identification software.

Iris Color Change, Postmortem, Taphonomy

G79 Child and Adolescent Victims in Forensic Autopsy: A Five Year Retrospective Study

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After attending this presentation, attendees will have a better understanding of the epidemiological features of child and adolescent victims in forensic autopsy and of the usual characteristics of homicide in the four to 19 years of age population.

Though literature on child abuse investigation of children less than three years of age is quite extensive, the data on forensic autopsy in the older population from four to 19 years of age is more limited. This presentation will impact the forensic community and/or humanity by providing data from a systematic five year retrospective study on this child and adolescent victim population in forensic autopsy.

In the province of Quebec (Canada), all forensic autopsies are performed at a centralized laboratory. During the five year period from 2000-2004, a total of 233 cases of children and adolescents deaths were autopsied in the four to 19 years of age population. Of those, the large majority of cases belonged to the 15-19 age group (139 cases), with the remaining cases equally distributed between the 4-9 and the 10-14 age groups (42 cases each).

Child and Adolescent Victims of Forensic Autopsy: Male victims were more frequently encountered than female ones (148 males for 75 females), this male predominance being more obvious in the 15-19 age group (male:female ratio of 23:19 in the 4-9 age group, 24:18 in the 10-14 and 101:38 in the 15-19). In this population, accident was the most frequent manner of death (44%), followed by homicide (24%), suicide (18%), undetermined (9%) and natural (4%). In the 4-9 age group, manner of death was mostly accident (57%) or homicide (37%). An important gender difference was noted in the manner of death. As a matter of fact, while male were more prone to die from accident (74%) than from homicide (17%), the opposite was observed for female (47% homicide compared to 37% accident). In the 10-14 age group, accident remained the most frequent manner of death (50%), followed by homicide (19%) and suicide (14%). Accidents are more frequent in males (58% of male victims

compared to 39% of female ones) while homicide is more frequent in females (28% of female victims compared to 12% of males). In the 15-19 age group, accident was once again the most frequent manner of death (38%), though less predominant in comparison with suicide (25%) and homicide (24%). In terms of gender, the relative incidences of each manner of death were more similar in this age group.

Homicide Victims: In a total of 54 homicide cases (24 females and 30 males), 13 cases belonged to the 4-9 age group, 8 to the 10-14 age group and 33 to the 15-19. The two most frequent methods of homicide found were firearm and sharp force, each at 27% of cases, followed by asphyxia (23%), blunt force (20%) and intoxication (3%). The gender distribution of homicide cases in the different age groups shows a strong female predominant ratio in the 4-9 and 10-14 age groups (9:4 and 5:3 respectively), while the opposite situation was observed in the 15-19 age group (10:23). An analysis of homicide methods by age group and gender will be presented. Overall, the results for the 4-9 age group are particularly interesting, clearly demonstrating predominance of sharp force in female victims compared to asphyxia in males.

In conclusion, this five year retrospective study gives new insight in the epidemiology of child and adolescent victims in forensic autopsy as well as a better description of homicide cases distribution.

Child Death Investigation, Adolescent Death Investigation, Forensic Pathology

G80 Hemoglobin SC Disease Presenting as Sickle Crisis After Outpatient Surgery: A Case Report

Wendy A. Lavezzi, MD, and Mitra B. Kalelkar, MD, Cook County Medical Examiner's Office, 2121 West Harrison Street, Chicago, IL 60612*

After attending this presentation, attendees will learn the significant signs, symptoms, and sequelae of Hemoglobin SC disease, and implement the use of postmortem hemoglobin electrophoresis in indicated cases.

This presentation will impact the forensic community and/or humanity by providing information on the importance of recognizing an occult hemoglobinopathy and its possible contribution to the cause of death.

Hemoglobin SC (Hb SC) disease is a hemoglobinopathy with approximately the same incidence as that of Hemoglobin SS (Hb SS) disease in American blacks. The typical presentation of Hb SC disease includes fatigue, dyspnea on exertion, frequent upper respiratory infections, sporadic mild jaundice, and arthralgias. The onset of complications due to Hb SC disease is usually in childhood, but many do not present until the teens or later. Rare reports of autosplenectomy in Hb SC disease exist, but most patients with Hb SC disease have splenomegaly. Unlike Hb SS disease, painful crises in Hb SC disease occur more frequently in the muscles and joints than in the abdomen. Although Hb SC can present with the same manifestations as sickle cell anemia, it is generally characterized by a milder anemia and fewer vasoocclusive crises, with a severity that is intermediate to those of sickle cell disease or sickle cell trait.

A 33-year-old black male who underwent outpatient surgery for arthritis that developed following ankle and foot fractures sustained three years prior when he jumped off a roof while fleeing from an offender. His preoperative medical history and physical were within normal limits, and he had a history of sickle cell trait.

The surgery lasted 2½ hours, with two hours of tourniquet time, and consisted of a right subtalar fusion and arthroplasty of the 2nd-4th right toes, with application of a cast. There were no complications during surgery. Ketorolac and local bupivacaine were given, a dressing was applied, and the tourniquet was removed. His airway device was then removed, and on the way to the recovery room he suffered sudden

cardiopulmonary arrest and was intubated, but expired despite resuscitative measures.

At autopsy, he had a plaster cast on the right leg, beneath which were intact sutured incisions and orthopedic hardware. The lungs were heavy and congested, and the mucosa of the gastrointestinal tract was hemorrhagic and appeared ischemic. The heart, liver, kidneys, and brain displayed no abnormalities. The spleen weighed 4 grams and had light tan, fibrotic parenchyma. Based on the appearance of the spleen, the family was contacted, and they stated that the patient did have sickle cell trait, and not sickle cell anemia.

Postmortem hemoglobin electrophoresis, however, revealed the presence of Hb SC disease. Microscopy revealed pulmonary congestion with prominent sickling of red blood cells within vessels. Sickling of red blood cells was also prominent in the liver, heart, kidneys, meninges, adrenal glands, thyroid gland, and gastrointestinal tract. Sections of the spleen showed prominent fibrosis and calcification, consistent with autosplenectomy. It is theorized that release of the tourniquet caused a large amount of partially deoxygenated blood to re-enter the circulation and cause a sickle crisis. The cause of death was determined as sickle cell crisis due to hemoglobin SC disease, with ankle surgery following a fall from height as a significant contributing condition. The manner of death was accidental.

Sickle cell crisis in Hb SC disease is rare. Despite the fact that this patient underwent autosplenectomy, he had previously suffered no symptoms of Hb SC disease and believed throughout his life that he had sickle cell trait. The use of postmortem hemoglobin electrophoresis was invaluable in the determination of cause of death in this case.

Forensic Science, Hemoglobin SC Disease, Sickle Cell Crisis

G81 Hola Camp Massacre Kenya 1959

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The goal of this presentation is to demonstrate where in cases where either living victims of violence or the dead resulting from violent acts' it is important to investigate the medical history of the victim when conducting the clinical examination or the autopsy.

This presentation will impact the forensic community and/or humanity by drawing the attention of the forensic community to the fact that these cases do occur. The complete forensic evaluation that includes a review of the clinical record for all patients undergoing a full autopsy examination should become a routine procedure in such cases.

The "Hola Camp Massacre" occurred on 3 March 1959 in a detention camp run by the British Colonial Government of Kenya during the Mau Mau rebellion. The detention camp, established early in the Mau Mau Kikuyu rebellion that raged from 1952 to 1960 was situated in a remote area of the coastal province of Kenya.

The camp was staffed by Kenyan African warders and commanded by British Colonial prison officers with locally recruited Kenya European civil servants.

The following facts are beyond dispute.

The warders were authorized to use reasonable force to induce resisting camp detainees to work against their will. In the incident under consideration, warders used unauthorized excessive violence with clubs, sticks and body kicks.

Eleven 11 men were killed and some sixty 60 injured. Of these, 26 men were admitted to the camp hospital in a state of surgical shock, with extensive bruising, subcutaneous hemorrhaging and hematomata in many areas of the body surfaces.

Clinical examination revealed signs of severe chronic deficiency of Vitamin C, (Ascorbic Acid).

The eleven bodies were flown to the Medical Research Laboratories in Nairobi, where the author performed autopsy examinations in his capacity as the Police Forensic Pathologist.

The autopsy examination revealed extensive subcutaneous hemorrhages, hematomata and laceration of muscles in the region of the head, neck, torso and the limbs. No serious fractures were found in the bodies, except for a linear fracture in the occipital skull bone in one case. All internal organs were anatomically intact. There were hemorrhages in the respiratory, the gastro-intestinal tracts and in the urinary bladder. There was severe pulmonary edema.

The cause of death in these cases was determined to be due to acute hemorrhagic shock; with complications resulting from their state of severe Vitamin C deficiency at the time they received the multiple beatings with a club-like weapon.

The patients in hospital were diagnosed as suffering from acute traumatic hemorrhagic shock and responded to therapeutic doses of Ascorbic Acid (Vitamin C) and to supportive medical treatment. The clinical diagnoses showed clearly that the detainees were suffering from Vitamin C deficiency or Scurvy when they were subjected to the beatings.

The important principle as illustrated by these cases is that the forensic scientist must evaluate both the complete clinical syndrome presented by the victim of an assault and the autopsy examination diagnosis as a whole concept.

The question arises whether similar blows inflicted on healthy detainees could have produced the acute hemorrhagic shock syndromes that were suffered by the beaten detainees?

This presentation will show that in terms of the above principle, the answer must be negative.

Hola Camp, Massacre, Kenya

G82 Comparison of Wound Severity Between Center-Fire Rifle Projectiles and Shotgun Slugs

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After attending this presentation, attendees will understand how the kinetic energy and fragmentation properties of a missile affect the extent of firearm wounds in a human body.

This presentation will impact the forensic community and/or humanity by contributing to the understanding of the relationship of a missile's kinetic energy and its wounding pattern in actual firearm wounds.

Introduction: Contemporary understanding of wound ballistics relates the severity of wounds to the temporary cavity that a projectile creates as it passes through the body tissues. This cavity is felt to be proportional to the kinetic energy (KE) possessed by the projectile. KE is related to both the mass (m) and the velocity (v) by the well-known formula: $KE = \frac{1}{2} mv^2$. This concept generally fits with ballistic experiments using gelatin, and accords well with general practical experience of forensic pathologists. There is little literature; however, that analyzes this relationship in actual firearm wounds. This study sought to explore this hypothesis using scientific methods on examples from medical examiner cases. A comparison was made of wounds produced by high velocity, center-fire rifles projectiles (CFRP) with those produced by shotgun slugs (SGS). The basis for this comparison is that CFRP have a relatively small mass and extremely high velocity while SGS have a large mass and a relatively low velocity.

Methods: A search was performed of the records at the King County Medical Examiner Office, Washington, for SGS and CFRP wound cases over the last 12 years – from mid-1993 to mid-2005. For these cases, the caliber of the CFRP and gauge of the SGS were obtained from the investigator reports, along with an examination of the weapon, ammunition, and recovered projectile. Only head wounds were used to

compare wounds produced by CFRP and SGS. A grading scheme was developed based on head wounds documented in the autopsy reports, radiographs, diagrams and photographs. Grade I was limited to a skin laceration at the entry site, with minimal fractures or avulsion injuries. Grade II included complex skull fractures and limited avulsion of the scalp, skull, or brain. Grade III involved extensive avulsion of the scalp, skull, or brain.

Results: A total of 80 suicide and homicide SGS and CFR cases were evaluated, the majority of which were contact wounds of the head. In all the SGS cases, the slugs exited the body. Forty-two of 61 CFR cases showed fragmentation in the body. Overall, 64 cases were suicides and 16 were homicides. All of the contact head wounds resulted in extensive destruction of bony and soft tissue structures in the path of the wound with complete or near complete avulsion of the brain. For CFR, both high (e.g., .223, 3030, 30-06 caliber) and intermediate velocity (e.g., .45 caliber) ammunition were considered. Using the KE equation, it was calculated that the extent of the wound of a .223 should be approximately 90% that of a SGS wound. In the majority of SGS cases, slugs exit the body; therefore not all of the KE is transferred to the tissues. The majority of CFR projectiles fragment and remain in the body; however, resulting in the maximum transfer of KE to the tissues.

Conclusion: The results support the general observation that the extent of wounds of SGS is similar to that of CFR wounds. The objective of this study was not to compare the gauge and manufacturers of the weapons, but to provide the results of a general observation of wounding characteristics using scientific methods. CFR bullets fragment because of their high velocity and not because of hitting bone. The majority of the time, SGS do not fragment because of their lower velocities. Fragmentation allows for the dispersion of kinetic energy to the tissues. CFR projectiles possess approximately 90% of the energy of that of SGS; however, because most CFR bullets do not exit, there is more transfer of kinetic energy to the tissues than that of SGS bullets, where majority exit the body.

Firearm Wounds, Shotgun Slugs, High Velocity Center-Fire Rifles

G83 A Comparison of Penetration Distances for Five Ballistic Gelatins to a BB Gunshot Wound to a Live Human Forearm

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After attending this presentation, attendees will see the accidental result of a BB gunshot and learn how ballistic gelatin preparation methodology can affect penetration results.

This presentation will impact the forensic community and/or humanity by demonstrating the only documented case where precise BB gun firing distance is known for a wound to a live human forearm. The penetration distance was determined using X-Rays. This data was then compared with recreated BB gun firings into five (5) different ballistic gelatins to determine which average penetration distance is the closest to this single human case.

Misuse of BB guns causes a significant number of injuries each year. One of the authors was subjected to such misuse and the result was a penetrating wound to the proximal anteromedial aspect of the right forearm. The subject was a healthy, 37-year-old male with fairly well muscled forearms due to years of baseball playing. Fortunately, this accident occurred in a laboratory setting and all parameters were recorded. The gun was a Daisy-brand Powerline Model 1200. This carbon dioxide powered pistol can fire a standard steel BB at up to 420 feet/second. In this case, the muzzle was located precisely 126 cm from the subject's bare forearm and the gun was equipped with a fresh CO₂ cartridge.

Radiographs were made and the BB was noted to have penetrated just over 63 mm into the flesh (after magnification was taken into account). The BB was surgically removed under fluoroscopy. The surgeon noted no involvement of the radius, ulna or major neurovasculature. However, the BB did pierce the interosseous membrane. The wound was irrigated and sutured closed with no significant complications.

It is an extremely rare case when such precise data is known about an actual gunshot wound to a live human being. It afforded the authors an interesting opportunity to compare the BB penetration in this person to a laboratory-based series of experiments utilizing ballistic gelatins.

In order to perform better controlled studies on the damaging effects of various bullets passing through soft tissues, ballistic gelatin was created many years ago. The gelatin is said to simulate the density and viscosity of human and animal muscle tissues. A standard gelatin powder (250 Bloom Type A Ordinance Gelatin) was purchased from Kind & Knox Gelatine, Inc. (Sioux City, Iowa). There are a variety of methods published for the preparation of 10% gelatin blocks. Five were chosen for this study: 1) The manufacturer's directions; 2) The Vyse gelatin utilized by the FBI; 3) A technique in which the maximum temperature never exceeds 104 degrees F; 4) A technique in which the starting water is at 129 degrees F; and 5) A recipe published by Lewis et al. 1982. They appear to have relatively minor differences (mostly related to various temperatures and standing times).

Gels were poured into transparent hard plastic cups. Each cup was placed in a protective firing range and subjected to five BB shots from 126 cm away- using the same Daisy gun. A total of 25 shots were recorded for each of the five gelatin recipes and all penetration distances were measured with digital calipers. The data were stored in Microsoft Excel, then imported to Stata 8.0 (College Station, Texas) for analysis. The mean penetration distance for each recipe was: 1) 62.24 mm; 2) 43.25 mm; 3) 56.13 mm; 4) 64.22 mm, and 5) 40.98 mm. ANOVA testing was significant between all groups but the chi-squared analysis results were <0.05; therefore, variances were not equal and parametric testing was dropped. Kruskal-Wallis tests indicated statistically significant differences between the mean penetration distances for all the recipes. The Mann-Whitney test indicated significant differences between each recipe except when comparing one and four. Interestingly, the mean penetration distances for those recipes were the closest to the actual penetration depth in the live human subject (63 mm).

In summary, a live human subject was accidentally shot in a muscular area of his forearm with a BB gun. The penetration distance compared favorably with two of five ballistic gelatin preparations. Although the live human data consists of a population (n) of one, it appears to be the only such data in the medical literature. Based on this, it seems the preparation method for ballistic gelatin has significant effects on the penetration distance for BB gunshots.

BB Gunshot, Ballistic Gelatin, Live Human Forearm

G84 Suicidal and Homicidal Sharp Force Injury: A Five Year Retrospective Comparative Study of Hesitation Marks and Defense Wounds

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After attending this presentation, attendees will gain better knowledge of hesitation marks and defense wounds pattern in sharp force injury and its correlation to suicidal and homicidal manner of death.

This presentation will impact the forensic community and/or humanity by providing a systematic evaluation of hesitation marks and defense wounds in sharp force injury in the Quebec province (Canada) forensic laboratory from 2000-2004.

In sharp force injury cases, forensic pathologists often have to determine whether the injuries were self-inflicted or not. The presence of hesitation marks or defense wounds, respectively associated to suicide and homicide, has been accepted as useful characteristics in the evaluation of manner of death. However, very few studies in the forensic literature have systematically analyzed the features differentiating hesitation marks and defense wounds.

Over a five year period, in the Quebec province (Canada), all cases of suicidal and homicidal sharp force injury were retrospectively reviewed for the presence of hesitation marks and defense wounds. For each case, data on incidence, gender, age, hesitation marks/defense wounds localization, fatal wound(s) pattern and blood alcohol concentration (BAC) was compiled. Data was statistically analyzed in order to highlight differences between hesitation marks and defense wounds.

Hesitation marks: A total of 58 sharp force suicides (7 women; 51 men) were found, of which 74% (n=43) were positive for hesitation marks. Seventy-one percent of women and 74% of men presented hesitation marks and women showed a significantly higher amount of hesitation marks compared to men ($p<0.05$). Victims were aged from 23 to 83 years with an average age of 43 years for cases with hesitation marks. The three most frequent locations of hesitation marks were neck area in 46% of cases, followed by left thoracic area (44%) and wrists (39%). A positive correlation was found between the amount of fatal wounds and the amount of hesitation marks ($p<0.001$). When only one fatal wound was found, absence of hesitation marks was noted in 39% of cases. No correlation was found between BAC and presence of hesitation marks.

Defense wounds: A total of 149 sharp force homicides (59 women; 60 men) were found, of which 61% (n=91) were positive for defense wounds. A significant difference between male and female incidence was noted (71% compared to 54%; $p<0.05$) and women showed a significantly higher amount of defense wounds compared to men ($p<0.001$). Victims' age ranged from six months to 82 years with an average age of 42 years for cases with defense wounds. In terms of location, defense wounds were most frequently found on hands (78%), followed by arms (48%) and forearms (34%). Victims presenting with defense wounds showed a four times higher average amount of non-defense wounds. Absence of defense wounds was noted in 80% of cases showing only one fatal wound. A negative correlation was revealed between BAC and amount of defense wounds ($p<0.01$). Indeed, the highest amounts of defense wounds were noted in the absence of BAC, while the highest BACs were associated with the absence of defense wounds.

In conclusion, this retrospective study systematically compares features of hesitation marks and defense wounds and gives new insight on medicolegal expertise in sharp force injury cases.

Hesitation Marks, Defense Wounds, Sharp Force Injury

G85 Estimation of Postmortem Interval Using Bioelectrical Impedance of the Human Body

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After attending this presentation, attendees will understand the principles of a new tool for the estimation of postmortem interval, bioelectrical impedance of the human body, in addition to the traditional methods currently used.

The method of measurements using cutaneous bioelectrical impedance may impact the forensic community and/or humanity by becoming a valuable analytic tool for the estimation of the time of death in forensic medicine.

In medicolegal practice, being able to estimate the time of the death is of paramount importance. Particularly in cases of homicides (to accuse or exculpate an alleged criminal), the cases of postmortem manipulation of the remains (occurring especially in the cases of overdose), as well as in civil matters (for example succession rights). The interest to perform a technique to specify more precisely the time of the death in the first part of the postmortem interval lead to the development of a new method, based on the bioelectrical impedance of the human body.

Human body can be compared to an electrical complex circuit, containing water, electrolytes, and cellular membranes. A direct, or alternating low frequency (<5 KHz) current, applied to the body, was used to measure electrical resistance. The alternating current will reflect both the extracellular compartment (electric resistance) and the intracellular compartment (capacitive resistance).

Initially, measurements were made on 34 fresh bodies, with a known time of the death, less than five hours postmortem. Electrodes (patches) were applied on the skin with a distance between patches of 10 cm, on the chest, abdomen, arms and thighs. Bodies were placed in a room at constant ambient temperature (approximately 18 - 20 °C). Measurements were performed using an impedance meter that automatically recorded the values of resistance (R), impedance phase angle (theta), as well as the body temperature (rectal probe) and the ambient temperature. Measurements were recorded every ten minutes during the first 24 hours, then every 15 minutes. The available time for the measurements was dependent on the interval between death and the time of the postmortem examination.

The reactance (X_c) and the impedance (Z) were calculated using the recorded data. These results were compared with the postmortem interval. A variation was observed with the absolute values between the different bodies. On the other hand, with the relative values, a statistically significant arithmetic correlation, was noted between the values of reactance and impedance compared to the postmortem interval.

The method of measurements using cutaneous bioelectrical impedance may become a valuable analytic tool for the estimation of the time of death in forensic medicine.

Forensic Medicine, Postmortem Interval, Bioelectrical Impedance

G86 Postmortem Skeletal Survey Use in Pediatric Forensic Autopsies: A National Survey

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The goal of this presentation is to summarize a national survey of postmortem pediatric radiology practice, as reported by forensic pathologists. This will provide an understanding of current practice patterns and factors that may influence the type and extent of radiologic tools that are utilized in the postmortem evaluation of forensic pediatric cases, and introduce possible consideration for future practice including creative funding sources and community resources.

This presentation will impact the forensic community and/or humanity by assisting the forensic pathology community in analysis of how skeletal surveys are defined, and whether the current practices are providing adequate information in cases of unexpected pediatric death and/or suspected child abuse. In addition, it is anticipated that the results will provide suggestions for alternative techniques and resources, as well as creative funding sources in the area of postmortem radiography. Future research should include a cost-benefit analysis of various protocols.

Radiography is an essential tool in the evaluation of suspected physical abuse in the living child. Postmortem radiological evaluation is often included in the autopsy of a child or infant whose death is unexpected or suspicious for abuse. Just as in the living, discovery of subtle injury at autopsy may be dependent upon ancillary studies. Although the pathologist has the advantage of direct examination of the axial skeleton during the postmortem examination, a routine autopsy does not allow for examination of the appendicular skeleton. Dissection of distal extremities, for instance, may not be performed without radiologic studies that direct the pathologist to the location of potential injury. Previous studies have documented injuries such as metaphyseal fractures that were unsuspected on external examination.

According to the recently approved Forensic Autopsy Performance Standards of the National Association of Medical Examiners, "...The Forensic Pathologist or representative shall X-Ray all infants." In addition, in June 2004 a joint statement of the Society for Pediatric Radiology and the National Association of Medical Examiners was published, advocating the use of high quality radiographs in a postmortem child abuse investigation. The recommended appendicular postmortem survey includes a minimum of frontal views of each arm (two films), paired hands (one film), paired legs (one film) and paired feet (one film).

It has been recognized that the use of radiographs as an ancillary study in postmortem examinations is typically routine. The extent of such examinations, however, is not known. In the case of live children, recent studies suggest that in facilities with fewer numbers of pediatric cases, skeletal surveys are used less frequently and tend to include fewer images per study.

A mail survey of pathologist members of the American Academy of Forensic Sciences was distributed throughout the United States and its territories. The target population was pathologists who conduct autopsies on children ≤ 36 months of age. There were a total of three mailings, and a \$2 incentive was included with each initial survey sent. The objective of the survey was to (1) assess adherence to the NAME recommendations for postmortem radiography among pathologists conducting forensic autopsies in children ≤ 36 months of age, and (2) to describe the spectrum of postmortem skeletal survey practices in a national sample of pathologists. The response rate was 259/470 (55%). Data were analyzed utilizing univariate descriptive statistics.

Respondents reported handling one to approximately 2,000 pediatric cases per year in a given office. Nearly every respondent (99.96%) indicated that they obtained at least some imaging. The number of postmortem images obtained ranged from none to a "babygram" (i.e., one or two frontal films of the entire body) to a set of 19-30 individual films that include multiple views of the axial and appendicular skeleton, to full body MRI or CT scans. Most commonly, films were traditional X-Ray films although fluoroscopy and other techniques were also reported. Nearly one third of the surveyed pathologists reported routine use of the "babygram" as their sole postmortem radiographic tool.

Most surveys are performed on site, at the location of the autopsy laboratory, and most are funded at the expense of the office. Other funding sources included state budgets, grants and insurance billing.

Respondents reported using skeletal surveys most frequently when foul play or abuse is suspected. Not all pathologists utilize postmortem skeletal surveys in cases of presumed Sudden Infant Death Syndrome, or when foul play is not initially suspected.

Pediatric, Postmortem, Radiology

G87 Near Miss Incidents in Police Custody Suites in London, UK: A One Year Prospective Study

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After attending this presentation, attendees will be able to identify detainees at higher risk of harm while in police custody.

This presentation will impact the forensic community and/or humanity by reducing harm to detainees.

Background: Every year a number of deaths will occur in police custody within the UK. Potentially preventable deaths in police custody include those that involve illicit drugs, alcohol and deliberate self-harm. This study examined near miss incidents (NMI) that did not result in death in order to develop a better understanding of risk factors for detainees in custody. For the purposes of this research NMI have been defined as 'any incidents which resulted in, or could have resulted in, the serious illness, injury or self-harm of a detainee'.

Aims & Methods: A prospective study of NMI was undertaken for one year from May 2005 to 2006. Forensic physicians (FP) providing forensic medical services for the Metropolitan Police Service in London were asked to complete questionnaires on any incident that may have been considered an NMI. The questionnaire proforma was developed following a pilot study. Ethical Committee approval was given for this study. The aim of the study was to identify NMIs and to assess whether such incidents assisted in identifying indicators of increased risk within the police custodial setting. Data about all incidents were anonymised.

Results: 89 FPs voluntarily participated in this study. One hundred twenty-four proformas were returned in the 12 months study period. Ninety-six were returned identifying the FP and 28 were completed anonymously. 9 FPs returned > 2 proformas. Incidents were classified according to a) type and b) whether they were very likely or fairly likely to result in a fatality. Each incident could have more than one type. Of 124 responses, 36% said that if there had been no intervention, the incident was very or fairly likely to result in a fatality. Of the 124 incidents reported, 60 (48%) were related to suicide/self harm [28% likely to result in fatality]; 41 (33%) were drug related [49% likely to result in fatality]; 29 (23%) were alcohol related [45% likely to result in fatality]; 23 (19%) related to a medical condition / existing injury [65% likely to result in a fatality]; two (2%) were due to injuries sustained during arrest [both likely to result in a fatality]; eight (6%) were reported as being 'other' types of incidents [38% likely to result in a fatality].

Conclusion: This is the first prospective study examining risk factors for NMIs in police custody in the UK. The data will help identify particular groups of detainees at increased risk whilst in custody and will allow lessons to be learned in ensuring that care for such vulnerable individuals in custody is optimised.

Police, Near-Miss Incidents, Death in Custody

G88 Probability and Pathological Findings in Suicidal Versus Homicidal Hanging Deaths: A Case Study in Forensic Epidemiology

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After attending this presentation, attendees will be introduced to the application of weighted probabilities to pertinent pathological or other evidence to forensic decision making in a criminal matter; in the presented case study, the determination in a hanging death of suicide versus homicide.

This presentation will impact the forensic community and/or humanity by demonstrating how probability plays an important yet frequently unrecognized and/or improperly applied role in forensic decision making. This and other concepts of Forensic Epidemiology will be introduced in this presentation, raising awareness for forensic pathologists and others who rely upon population-based data from which to draw conclusions.

Probability is in constant use in forensic settings as a means of weighing the accuracy of specific conclusions, and it is used nearly as often to give weight to conclusions. Opinions that include the terms “risk” or “likelihood,” or the expressions “most often” or “would be expected (or not expected)” are all variations of probabilistic assessments. Such opinions imply both an underlying basis in population-based data as well as a methodologically sound synthesis of such data. When probabilistic opinions are proffered in a forensic setting they should be scrutinized carefully for their basis in epidemiologic data, as well as how the data has been interpreted to apply to the case in hand.

A case study is presented in which a 26-year-old Aboriginal man was found hanging from a sheet in a jail cell in Darwin, Australia in February of 1986. The postmortem examination revealed evidence of unilateral neck organ fracture (thyroid cartilage) and was ruled a suicide. The decedent’s widow believed that the death was a homicide, and brought forth collateral evidence supporting the charge. An international panel of eight forensic scientists was convened to re-examine the evidence, and it was concluded that there was sufficient evidence to justify a disinterment of the decedent, in part due to the fact that the neck organ injury was thought to be unlikely given the circumstances of the hanging.

In 2004 a civil case was brought against several defendants, including the forensic pathologist who conducted the postmortem examination, charging them with a conspiracy to obscure the murder. One of the theories raised by the defense was that neck organ fractures were common in suicides resembling the circumstances of the death, a probabilistic determination. For this reason, a forensic epidemiologic review of the case was conducted, including a review and analysis of the relevant literature.

A comprehensive review of the published literature on observational studies of hanging deaths in which neck organ injury was the independent variable revealed four validated predictors for the presence of neck organ injury of varying strength (in nine studies describing 1342 cases): Age greater than 30 (strong), duration of suspension (moderate to strong), ligature width of 1-2 cm or less (moderate), and suspension type (weak to moderate support for full versus partial suspension).

Based on the findings in the literature, the features of the this hanging (age 26, brief suspension duration [45 minutes], >4 cm ligature width, partial suspension [feet in contact with the ground]) it was determined that the neck organ injuries observed in the postmortem examination were unlikely to have arisen from the observed circumstances of the hanging. Further, out of 1342 cases in the literature, ~180 were in males <30 years of age, and among these there were only ten cases of neck organ fracture. Although the ten cases did not describe the presence of the other three risk factors, approximately 75% of suicidal hangings in which ligature width

is described involve a narrow (<2 cm) ligature, and 25-50% are complete suspensions. It was reasonable conclude that no more than 10, and likely five or less of all of the hangings described in the literature review could have produced the same type of injuries as those seen in this hanging, given the risk factors present. The prevalence of potentially similar cases in the database ranged from 0-0.7%.

Based on the forensic epidemiologic review, it was opined that 1) contrary to the assertion by the defense, the neck organ injuries observed in the decedent do not commonly occur in similar circumstances, and 2) such injuries are rare in suicidal hangings with the predictive variables present in the subject case, as a reasonable scientific certainty. A Bayesian analysis of the evidence will be presented.

Hanging, Probability, Homicide

G89 Accuracy of Death Certification and Medical Examiner Notification in Nova Scotia

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After attending this presentation, attendees will gain an appreciation of the spectrum of problems associated with errors in death certification and medical examiner notification.

This presentation will impact the forensic community and/or humanity by providing the framework for assessing and designing interventions to improve the accuracy of death certification. Improvements in the accuracy of death certification have important implications for accuracy of Vital Statistics, basic science research, public health policy, and civil/criminal law implementation. Most importantly, the accuracy of death certification is important for families, in terms of peace of mind and insurance claims.

Background: Information from Vital Statistics is an important resource utilized by clinical researchers, public health authorities, and officials of the Department of Justice. Major errors in death certification have been identified among physicians in academic institutions, as well as among officials in coroner systems.^{1,2} At the very least, the accuracy of this information has implications for basic medical research, public health policy, and civil/criminal law. Most importantly, the accurate certification of death has important implications for the families of the decedent in terms of peace of mind and insurance claims. As such, it is important to assess and to design interventions to improve the accuracy of death certification on both a regional and national scale.

Hypothesis: The role of the Medical Examiner Service (MES) is to determine the cause and manner of death in circumstances defined by the Fatality Investigations Act (FIA). Under the terms of the FIA, all citizens have the obligation to report a death, although most commonly this is a member of a law enforcement agency or a physician. Despite established guidelines for reporting, physicians often miss cases. There are likely two components contributing to the numbers missed cases.

1. Non-compliance with the established reporting guidelines (not sure when to report)
2. Inaccurate certification of death (not sure how to accurately assign cause or manner of death)

Objectives: The objectives of this study are threefold: 1) to determine the proportion of cases missed during a two year period (2004-2005); 2) to determine the mechanisms by which these cases were ultimately identified; and 3) to determine why these cases were originally missed as medical examiner cases.

Methods: All available case files from the Nova Scotia Medical Examiner Service over a two-year period (January 1, 2004 to December 31, 2005) were reviewed and those classed as “missed cases” were included in the study. The nature of the missed cases was documented with respect to the original certification of cause and manner of death, the final certification of cause and manner of death, the mechanism by which the cases are identified as a “missed case,” as well as various epidemiological aspects of the cases. The results were evaluated using descriptive statistical techniques.

Results: The total number of medical examiner cases for the study period is 1516 (742 cases in 2004 and 774 cases in 2005). Of these, the “missed cases” made up 11% of the total number of cases investigated (total 167 missed cases: 80 cases in 2004 and 87 cases in 2005). The mechanisms by which “missed cases” are identified include cremation approval 56% (93 cases), Vital Statistics 28% (46 cases), hospital personnel 6% (10 cases), Trauma Registry 4% (7 cases), physicians 3% (5 cases), family of decedent 1% (2 cases), policing agency 1% (2 cases), and other 1% (2 cases). In 22% of cases (37 cases) the physician classified the death as unnatural, yet failed to notify the medical examiner service. In 59% of cases (99 cases), the physician misclassified the case as natural when the manner was accidental.

Conclusions: Both non-compliance with the established reporting guidelines (not sure when to report) and inaccurate certification of death (not sure how to accurately assign cause or manner of death) contribute to the numbers of “missed cases.” This study shows that 11% of medical examiner cases are originally “missed,” and are discovered by a variety of mechanisms. This number represents the “tip of the iceberg” in that a significant proportion of “missed” deaths are detected by cremation approval. It is worth noting that burial in Nova Scotia does not require approval by the Nova Scotia Medical Examiner System.

References:

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Death Certification, Notification of Medical Examiner Service, Missed Cases

G90 Comparative Analysis of Medical Examiner and Coroner Systems of Medicolegal Death Investigation: Is There a Bias Toward Manner of Death?

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After attending this presentation, attendees will become aware of some of the differences between a Coroner’s and a Medical Examiner’s jurisdiction regarding the relative percentages of natural and violent deaths that are investigated by the respective jurisdictions.

This presentation will impact the forensic community and/or humanity by encouraging critical examination of the differences between Coroner- and Medical Examiner-based medicolegal death investigation systems in order to learn more about the motivating factors behind the decisions to investigate various types of deaths; to retain the most positive and beneficial aspects of both systems; and, ultimately, to promote practices that are sound from an investigative standpoint yet also cost-effective.

Background and Objective: In the United States, two different types of medicolegal death investigative systems, namely, the Coroner and Medical Examiner, exist, the former, headed by an elected, often lay official, the latter, by an appointed physician, sometimes a pathologist. The origin of the Coroner system dates back to English common law when the “crowner” was purely a political position; not surprisingly, such political overtones have persisted to the present day. The Medical Examiner system, on the other hand, is, at its best, led by a physician, preferably a pathologist, who has formal training in medicolegal death investigation and in the performance of forensic autopsies. The fundamental philosophical differences between the Coroner and Medical Examiner systems exert a substantial influence on the nature of the cases that are selected by the medicolegal official to come to autopsy; specifically, that the Coroner, in an effort to minimize spending and stay within the budget, is more likely to authorize cases for autopsy that will potentially result in a criminal proceeding (or a high-profile civil litigation), most frequently violent (non-natural) deaths, while the Medical Examiner will have a greater tendency to pursue sudden unexplained deaths, the majority of which result in certification of a natural manner of death. The objective of this study was to determine whether this hypothesis was indeed valid by comparing a contemporary Coroner and Medical Examiner system.

Methods: This study reviewed deaths spanning a 14-year period from 1992-2005 that were reported to a coroner’s office (the Charleston County, South Carolina Coroner) and over a 6-year period from 2000-2005 reported to a medical examiner’s office (the State of Delaware Office of the Chief Medical Examiner [OCME]). Data were coded and analyzed using the program SPSS for Windows, Version 14.0.

Results: The breakdown of cases according to manner of death for the two respective jurisdictions is as follows:

Jurisdiction	Number of Deaths	Natural	Accident	Homicide	Suicide	Undetermined
Charleston County Coroner, SC	2,638	827 (31.3%)	940 (35.6%)	422 (16.0%)	345 (13.1%)	104 (3.9%)
Delaware OCME	4,608	2,302 (50.0%)	1,437 (31.2%)	230 (5.0%)	529 (11.5%)	110 (2.4%)

Comparison of the two medicolegal systems showed a negative correlation ($r = -0.046$ [$P = 0.018$]) for 2,638 subjects. The difference between the means of the two groups was 0.171 (95% CI = 0.107 to 0.235; student’s $t = 5.3$; $df = 2,637$; $P < 0.001$).

Conclusion: The proportion of natural deaths appears to have been substantially greater in the State of Delaware Medical Examiner jurisdiction while the percentage of homicides was significantly higher in the Charleston County, South Carolina Coroner’s Office. While the obviously higher degree of inflicted fatal injury in Charleston County, South Carolina is beyond the scope of this study, the greater percentage of natural deaths in the Delaware OCME supports the hypothesis. More detailed analyses of these respective trends are necessary in order to create the most effective and efficient medicolegal death investigative systems possible.

Medicolegal Death Investigation, Manner of Death, Coroner/ Medical Examiner

G91 Preliminary Findings of the Bureau of Justice Statistics 2005 Census of Medical Examiner and Coroner Offices

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After attending this presentation, attendees will gain an enhanced understanding of the nation's death investigation systems. The presentation will be based on findings from the Bureau of Justice Statistics (BJS)-funded Census of Medical Examiner and Coroner Offices (CMEC).

This presentation will impact the forensic community and/or humanity by providing the forensic community with reliable and previously unavailable information on the personnel, functions, resource needs, workload, and specialized death investigations reported by U.S. medical examiner and coroner offices.

Medical examiner and coroner offices serve the public by conducting medicolegal investigations, primarily of unnatural or suspected unnatural deaths, throughout the United States. The 2005 Census of Medical Examiner and Coroner Offices (CMEC) represents the first data collection effort by the Bureau of Justice Statistics (BJS) to focus on medicolegal investigations of death. The goal of the census is to provide accurate and timely information on the capabilities and resource needs of medical examiners and coroners. RTI International, a nonprofit research organization, administered the census on behalf of BJS.

Medical examiner and coroner offices were asked to voluntarily complete the census, which covered a variety of topics, including jurisdictions, budgets, funding sources, staffing, workloads, data and database usage, records and evidence processing and retention, and investigations of infant deaths and unidentified decedents. The collection effort began in October 2005, when the census was mailed to 1,920 medical examiner and coroner offices. As Hurricane Katrina had recently devastated the states of Louisiana, Mississippi, and Alabama, the census was not sent to these states during the first phase of the data collection effort. In February 2006, the census was mailed to 154 medical examiner and coroner offices in Alabama and Mississippi. The data collection effort will be finalized by August 2006.

A multimodal data collection process enabled the death investigation offices to complete the census by mail, facsimile, or Web (<https://cmec.rti.org>). All offices were mailed a unique access code for Web access. In a final effort to improve response, RTI and BJS developed a reduced-length survey instrument that collected basic information about laboratory operations. Currently, the overall response rate for the CMEC is 85%, and the response rate for offices covering populations of 250,000 or more is 92%. Of the 49 states included (Louisiana was omitted), 23 had a 100% response rate across their medical examiner and coroner offices. Overall response rates for medical examiner and coroner offices were similar.

This presentation will highlight similarities and differences in the nation's medicolegal death investigation systems. Variables include the types of systems found across states, expenditures, caseload measures by type of procedures involved, turnaround times for case completion, investigation protocols, and reporting levels for specialized death investigations. For example, the geographical distribution of types of offices, as well as aggregate population and jurisdictional coverage, will be detailed. In addition, the number of accepted cases for 2004 will be presented, with discussion of the various functions performed on a case, such as death scene investigation, autopsy, toxicology, and crime scene processing. This presentation will also summarize the policies for handling unidentified human decedents and infant deaths, as well as the related caseloads and resource needs.

The CMEC provides valuable information on the status and needs of medical examiner and coroner offices in the United States. Information collected in the 2005 CMEC may emphasize specific funding requirements or other areas that require further assessment of the nation's death investigation systems. These preliminary data represent the compiled data that will be available in a comprehensive BJS report on <http://www.ojp.usdoj.gov/bjs>. Understanding these issues will inform the development of plans to improve both the efficiency and functionality of medical examiner and coroner offices.

Medical Examiner, Coroner, Census

G92 Pituitary Macroadenoma Presenting as Hypothermia: A Case Report

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The goal of this presentation is to present an uncommon cause of hypothermia due to a brain tumor and highlight the importance of central nervous system causes that affect body temperature regulation.

This presentation will impact the forensic community and/or humanity by demonstrating an unusual cause of hypothermia.

Hypothermia is diagnosed when an individual's body temperature is below 95°F (35°C). In forensic pathology practice, the most common cause of hypothermia is exposure to low temperatures without adequate warming measures. It is not uncommon for individuals to present to the emergency room having been exposed to extremely cold temperatures and then subsequently to die. In these cases in particular, forensic pathologists must rely on documentation of body temperature within the medical records to assess whether hypothermia may have caused or contributed to death. In cases in which hypothermia is a cause or contributing factor to death, the manner of death is rendered as an accident. The extreme ages of life, those encompassing the very old and young, are most vulnerable to hypothermia because of debilitating disease or lack of self-nurturing skills. The body responds to hypothermia by increased heat production through peripheral vasoconstriction and shivering. Shivering ceases between 85-90°F and the loss of hypothalamic function to regulate temperature ceases below 85°F. Once compensatory measures fail to increase heat production, individuals can experience ventricular fibrillation and death.

Less commonly, and rarely documented in the literature, brain lesions can cause hypothermia.

A 59-year-old black woman who initially came to clinical attention in May 2006 after falling out of her wheelchair and hitting her head on a concrete floor in her room at a nursing home. She had a history of a brain tumor and was on warfarin for deep venous thrombosis. The subject was taken to the emergency room to obtain a brain CT scan, as mandated by the nursing home protocol. En route to the hospital, the patient became hypotensive and was cool to touch. In the emergency room the patient was hypothermic with a temperature of 29°C (84°F) and continued in a hypotensive state. A CT scan of the head was negative for hemorrhage. Once her blood pressure was stabilized with vasopressors, the patient's hospital course was complicated by administration of antibiotics for a presumptive diagnosis of sepsis and subsequent development of anaphylaxis. She was intubated after upper airway swelling and developed adult respiratory distress syndrome, which ultimately led to her demise two days later.

At autopsy, there was diffuse consolidation of all the lung lobes and microscopic examination revealed diffuse hyaline membranes without organization. There was minimal laryngeal swelling. The skull showed evidence of a prior craniotomy site and an organizing subdural hematoma. The sella turcica was markedly enlarged and contained a 2.3 X 1.8-cm pituitary macroadenoma containing a small area of hemorrhage. The

macroadenoma grossly compressed and distorted the overlying hypothalamic area. Microscopic sections of the hypothalamic area revealed a symmetrical compressive infarct consisting of rarefaction of glial tissue, numerous axonal spheroids, and collections of parenchymal hemosiderin. The cause of death rendered in this case was hypothermia due to pituitary macroadenoma and the manner of death was rendered as natural.

This is an unusual case of a macroadenoma causing overlying compression of the hypothalamus. It is concluded that compression of the overlying hypothalamic area by the pituitary macroadenoma caused a disruption in the thermoregulatory function of the hypothalamus, thus causing hypothermia. The fall may have contributed to focal hemorrhage and enlargement of the pituitary macroadenoma with further compression of the hypothalamus and subsequent development of symptoms.

Hypothermia, Pituitary Macroadenoma, Death

G93 Diatoms and Their Forensic Significance

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The goal of this presentation is to demonstrate that diatoms could be critical evidence in criminal investigations when aquatic communities are involved. This research shows that diatoms are a good example of trace evidence and very valuable investigative tools, which can be used to link an individual to a crime scene. Additionally, this study findings support that these microorganisms can be recovered by using a simple methodology; and providing investigators with a reliable and quick technique that could help them determine the presence of diatoms in physical evidence recovered from a crime scene and/or individual.

This presentation will impact the forensic community and/or humanity by showing that diatoms could be critical evidence in criminal investigations when aquatic communities are involved. This study will provide investigators with a simple, reliable and quick technique that could help them determine the presence of diatoms in physical evidence recovered from a crime scene and/or individual. These results can be used to educate crime scene investigators and police officers on what kind of valuable trace evidence should not be overlooked at a crime scene or evidence items that show the presence of soil, mud, or water.

Diatom analysis could help determine if the person was dead or alive when the body is removed from the water. Because of the diatoms vary morphologically and taxonomically depending on their habitat, it is possible to determine the location or site of drowning. Moreover, if there is a possibility of linking a victim to the site of the drowning, there is also a possibility of linking a suspect to a crime scene. It is imperative to try to recover as much evidence as possible from a crime scene, especially; the type of evidence cannot be seen with naked eye such as trace evidence. Therefore, recovering diatoms from a crime scene or from articles of clothing of the victim or a suspect can provide an important evidence for use in criminal investigations. The use of diatoms for forensic purposes in the United States is very limited and under-utilized

Samples used in this study were collected from three different bodies of water; marine (beach shore), brackish (estuarine), and from a freshwater source (lake). Neutralized buffered formalin (NBF 10%) was added to each sample to fix and help in the preservation of the diatoms. The temperature and the pH of the water were recorded at the time the samples were collected, as well as the ambient temperature. Samples were stored at 4°C.

Under restrict sterile condition; the samples were centrifuged for three minutes at 2982 rpm and then re-suspended in a few drops of distilled water. A drop of each sample was placed on a glass slide and a high refractive index mounting medium was used to fix the cover slip to the slide. The samples were observed under the microscope for the

presence of diatoms, identification, and comparison. Images were recorded of the different genera observed under the microscope. The second experiment consisted of manually transferring some of the samples to different articles of clothing, in a spotted manner. The articles of clothing examined were a white cotton t-shirt, white socks, and jeans. Each piece of clothing was cut in small pieces measuring three by four inches. The samples once impregnated with the marine, brackish and freshwater samples were placed in plastic containers (16 oz) used for this experiment. These samples were treated and processed in the same manner as the first experiment.

Diatoms were recovered from all the samples collected, and a qualitative analysis was performed. Diatoms were abundant in the estuarine and freshwater samples. On the other hand, the seaweed sample yielded the least amount of diatoms, and only six different genera were observed. To determine if a common habitat or source could be indicated; comparison of the diatoms from different samples showed a total of 23 genera in all samples collected. For recovering the diatoms of different fabrics such as pieces of t-shirt, sock, and jean material, results showed 66% success. These findings prove that diatoms can be recovered, analyzed and can be categorized as trace evidence.

In conclusion, diatoms have proven to be a powerful tool that can be used as evidence in forensic cases. It was concluded that diatoms could be transferred to different items of clothing, car carpets, sneakers, etc., if an individual comes in contact with an area where diatoms are expected to be present. These results can be used to educate crime scene investigators and police officers on what kind of valuable evidence should not be overlooked at a crime scene or evidence items that show the presence of soil, mud, or water.

Trace Evidence, Diatoms, Crime Scene

G94 Evaluation of NT-proBNP as Marker of Heart Failure in Postmortem Examination

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The goal of this study was to evaluate the new biochemical marker NT-proBNP in postmortem examination as a tool for diagnosis of heart failure in cases related to coronary ischemia.

This presentation will impact the forensic community and/or humanity by showing that measurement of NT-proBNP is reliable in postmortem examination and should be considered as a useful tool for autopsy diagnosis of acute or chronic heart failure, whatever its origin.

Introduction: Natriuretic peptides are synthesized and secreted by cardiomyocytes in response to increases in wall stress and their plasma levels are elevated in patients suffering from myocardial infarction with systolic dysfunction. Many publications consider one of these peptides, BNP, as an excellent marker of heart failure. Recently, in clinical medicine, the amino terminal part of pro-BNP (NT-proBNP) was introduced which is secreted in equivalent proportion to BNP. According to the published studies, this new cardiac marker has a longer half-life and a better stability in comparison to the BNP. Moreover, many authors considered high levels of NT-proBNP as an independent predictor of mortality.

The first goal of this study was to measure the levels of NT-proBNP in patients with coronary syndromes and compare them to a control group. As serum is not always available during postmortem examination, the second goal of this study was to evaluate a correlation between NT-proBNP levels measured in serum, blood, aqueous humor and pericardial fluid.

Material and Methods: This study included 34 cases. 25 patients presented an ischemic heart disease (21 men and four women), in 15 of them postmortem examination revealed an acute coronary syndrome. In a control group were included nine cases (5 men and four women) without cardiac pathology. According to the clinical history and autopsy findings, the cases were classified into four groups. For each case, an autopsy followed by a histological examination was performed. The examination of the heart included a macroscopical examination and the analysis of at least five slides of the myocardium, stained with haematoxylin and eosin, and with von Gieson trichrome. The putrefied cases were excluded from the study.

Postmortem blood samples were centrifuged in order to obtain "serum." The NT-proBNP measurements were performed in serum, blood, aqueous humor, and pericardial fluid using a chemiluminescent immunoassay kit (Elecsys 2010 analyzer, Roche Diagnostics).

Results: The highest serum levels were measured in patients with acute coronary syndrome associated with chronic ischemic disease revealed by a clinical history or detected at autopsy. No significant difference was observed between patients with acute coronary syndrome and without previous ischemic disease in comparison to a control group.

In this preliminary study, the levels measured in blood, aqueous humor and pericardial fluid were in accordance with levels obtained from serum.

Conclusions: Measurement of NT-proBNP is reliable in postmortem examination. In this study, the results obtained for patients suffering from coronary syndromes are compatible with clinical data. NT-proBNP measurement should be considered as a useful tool for autopsy diagnosis of acute or chronic heart failure, whatever its origin.

Natriuretic Peptides, Coronary Syndrome, Heart Failure

G95 An Unusual Case of Sudden Death

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After attending this presentation, attendees will learn the importance of implementing the dissection of the atrio-ventricular node in all necropsies; but particularly in cases of sudden death.

This presentation will impact the forensic community and/or humanity by illustrating the utility of conduction system evaluation and its association with mechanism of death as discovered in conjunction with an unusual breast neoplasm.

A 49-year-old Asian female was found dead in her residence. Two weeks prior to her death, she presented to a local Emergency Room for pain and swelling of her right breast. Clinical examination revealed bilateral breast masses, suggestive of carcinoma. A mammogram was ordered, but never performed due to the patient's demise. Review of medical records reveal a mammogram performed six months prior, which was interpreted as negative. Evidence of a recent biopsy was identified at the time of autopsy; however, despite extensive searching the biopsy results were never located. The autopsy revealed a 7 cm mass in the right breast and a 2 cm mass in the left breast, both of which had an appearance clinically suggestive of carcinoma. The adrenal glands were completely replaced by tumor nodules. The heart weighed 195 gm and the posterolateral left ventricular wall and interventricular septum contained soft, white masses that ranged in size from 0.6 cm to 3.5 cm. There was no pericardial effusion or pericardial thickening. Of note, there were only two (right neck and supraclavicular) enlarged lymph nodes but no axillary lymph nodes; despite the large tumor burden in the breasts. A small

nodule was identified in the right lower lobe of the lung. The remainder of the internal organs were unremarkable. Microscopic examination of the breast masses revealed a primary non-epithelial breast neoplasm with involvement of the heart, lung and adrenal glands. Immunohistochemical analysis of the tumor was consistent with a large cell lymphoma of T-cell origin (CD 45 +, CD 3 +, CD 20 -, pancytokeratin -, CD 57 - and ALK1 -). Myocardial involvement included transmural infiltration, as expected from the grossly visualized masses, as well as focal permeation of the atrioventricular node, which was not associated with a grossly visible lesion. The enlarged lymph nodes were negative for lymphoma.

Primary breast lymphoma (PBL) is a rare form of extranodal non-Hodgkin's lymphoma accounting for less than 1% of all breast malignancies. Of these, the great majority will represent B-cell, rather than T-cell lymphomas. PBL is bilateral in up to 25% of the cases and the clinical presentation is similar to that of carcinomas of the breast, with the exception of slightly larger masses at the time of diagnosis. The growth is rapid, and several cases have been reported with recent negative mammograms, as in this case. Lymphoma has a high predilection to involve the heart, with an incidence of 25%, second only to lung carcinoma. Most cases with cardiac involvement are clinically silent and/or have non-specific symptoms until they present with sudden death.

The mechanism of sudden death related to carcinomas and lymphomas is often not determined, as these deaths generally are not considered 'unusual, unnatural or unexpected' deaths and therefore may not fall under the jurisdiction of the medical examiner or coroner. Known complications such as pulmonary emboli, treatment related problems, such as infection, or overall tumor burden are common enough processes that forensic pathologists typically don't perform autopsies. Even when performed in a hospital setting, it is unlikely that the hospital pathologist will examine the conduction system on such a case. As part of a thorough autopsy in a medical examiners office, the cardiac conduction system (in particular the atrioventricular node), is being examined more often and is occasionally revealing the underlying cause for the sudden death. Any foreign cell population, whether neoplastic or inflammatory in origin, in the atrioventricular node can precipitate an arrhythmia which may result in sudden death. In the presented case, not only were the cause and manner of death determined, but also the mechanism involved.

Breast Lymphoma, Atrioventricular Node, Sudden Death

G96 Use of Beta-APP Stain in a Case of Fatal Dog Attack

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After attending this presentation, attendees will understand the use of beta-APP histopathological stain to diagnose early central nervous system injuries.

Documentation of earliest stages of CNS injury is problematical. This presentation will impact the forensic community and/or humanity by making forensic pathologists aware of the use of beta-APP stain to document mechanism of death in cases where traditional autopsy techniques may be inadequate, and illustrate the use of this technique in a specific case with relatively short survival time.

β -APP is a protein that accumulates in damaged neurons and has been used to identify certain types of central nervous system injury. This study presents a fatal case of a dog attacking a two and one half-year-old child who was found unconscious by her mother in the dog's mouth with the dog "shaking the child back and forth." The child's shirt was described as soaked with blood, and there was an undetermined, but "small," amount of blood at the scene. There was no active bleeding from wounds upon the arrival of first responders. The child survived unconscious, tachycardic and hypotensive, with minimal bleeding from the wounds, for about 90 minutes during transport to hospital in the ambulance.

Autopsy confirmed soft tissue injuries (bite marks) to the neck, including ligamentous injuries in the posterior nuchal region, a small defect in the left jugular vein and a small epidural hemorrhage at the level of the fifth cervical vertebra. There was no subdural or subarachnoid hemorrhage. Likewise, there were no obvious gross or microscopic injuries to the brain, spinal cord or other internal organs to document the mechanism of death. Positive β -APP staining of axons in the corpus callosum and cerebral white matter was found, often in a perivascular distribution, and there was rather diffuse positive staining of many neuronal bodies. Although axons stained positively in the corpus callosum, the predominantly perivascular pattern of positive β -APP staining suggested diffuse hypoxic injury to the central nervous system resulting from shock and hypotension.

The β -APP stain documented potentially lethal injury to the central nervous system in the absence of other specific anatomic findings, and gives some indication of the mechanism of death. Generally, it is considered that β -APP stain is positive as early as approximately two hours survival time. The documented survival time of one and a half hours is consistent with this, although it is somewhat earlier than often reported. This case illustrates the use of β -APP stain as an early marker of central nervous system injury before more traditional markers of injury may be obvious at autopsy.

Beta-APP, CNS Injury, Dog Attack

G97 The Postmortem Diagnosis of Diabetic Coma

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After attending this presentation, attendees can expect to learn about a histology method that will make it easier to establish the postmortem diagnosis of diabetic coma and with a perspective to the significance of hyperlipidemia.

This presentation will impact the forensic community and/or humanity by significantly improving in the postmortem diagnosis of diabetic coma, but it is equally important to focus on the role of the lipids in the abnormal metabolism of diabetics and alcoholics.

The postmortem diagnosis of diabetic coma has always been difficult as one of the key markers of coma is a high glucose concentration, but this concentration is rapidly decreasing after death. Only few laboratories are able to quantitatively detect ketone bodies, and the diagnosis is usually based upon a combination of the history, the glycated hemoglobin concentration and a semi-quantitative detection of acetone.

It has long been known that in death due to diabetic coma there is a vacuolization of the proximal tubules of the kidneys. This vacuolization has until recently been believed to consist of glycogen, but it is now known that it represents an accumulation of triglycerides.

In a consecutive series of fourteen cases of diabetic coma, lipid staining was performed on cryostat sections of the kidneys. It was demonstrated in all of the fourteen cases that the vacuolization consisted of lipids. The sensitivity was thus 100 percent.

In alcoholic ketoacidosis, the lipid level in blood is high. So far, the authors have been able to perform lipid staining of one case of fatal alcoholic ketoacidosis and found the same phenomenon in the proximal tubules of the kidneys as in diabetic coma.

It is thus likely that the deposition of lipids in the proximal tubules is due to the high concentration per se and not increased permeability of the glomerulus as is seen in diabetics.

There has only been little focus on lipids in forensic medicine. One reason may be the need to do cryostat sections if lipids are to be demonstrated in the tissue. Otherwise they will be disguised as empty spaces due to dissolving in alcohol during tissue embedding.

Both in diabetic coma and in alcoholic ketoacidosis there are high levels of fatty acids and a disturbance of the metabolic balance that is influencing the citric acid cycle.

This study suggest that ketone body analysis should be done in cases of "fatty liver deaths" as there are indications that many of these deaths are due to the increased fatty acid concentrations following a binge and a subsequent development of ketoacidosis.

Diabetic Coma, Hyperlipidemia, Cause of Death

G98 Forensic Diaphanoscopy Imaging: A New Tool in Clinical Forensic Medicine

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After attending this presentation, attendees will understand the principles of a new tool, the forensic diaphanoscopy imaging, and the benefits in comparison with more classical method (forensic diaphanoscopy), illustrated with practical examples of traumatic diagnosis in clinical forensic medicine.

This presentation will impact the forensic community and/or humanity by demonstrating how forensic diaphanoscopy imaging can facilitate the diagnosis of signs of violence on living adult, victims of aggression, or abused children.

The classical forensic diaphanoscopy method has been developed following the observation that there were no valuable methods to diagnose non visible hematomas on living subjects, such as adults who had been assaulted or abused children. This method has been used in Lausanne for over ten years in forensic clinical expertise. It is a complementary method to the clinical examination.

However, the probability of detecting a hematoma with this method (sensitivity) or the probability to diagnose correctly subcutaneous hematomas (specificity) depends on the training and the experience of the examiner. An insufficiently trained person should expect false positive or false negative results. The classical method of forensic diaphanoscopy is based on a subjective interpretation of the examiner. This is the reason why the forensic diaphanoscopy imaging technique, based on objective data, has been developed.

Compared to the classical method, forensic imaging diaphanoscopy has the following characteristics:

1. Use of an annular light source, aimed to integrate a centered video camera, and to increase the diagnostic reliability.
2. An integrated miniature video camera will help maintaining a database of analyzed traumas, and offer a source of pictures to be processed later by digital systems (computers).
3. The digital processing of the acquired picture will improve both sensitivity and specificity in detecting non-visible subcutaneous hematomas.
4. Automatic adaptation of the light source intensity, based on subcutaneous tissues thickness (not depending on body mass and corporal topography) and skin pigmentation.
5. Automatic exclusion of opaque zones due to intravascular blood.
6. Hematoma documentation using digital processing.

Forensic diaphanoscopy imaging represents a major advance compared to the classical method to diagnose traumas on living subjects. The technique is more user friendly and reliable, due to the use of technological assistance and computer information processing. Creating legal documentation is easier and images from the system can easily be

integrated in reports. This reliable investigation method can easily complete a clinical examination by making or confirming the diagnosis of suncutaneous hematomas that are not readily visible. This method is also useful in excluding this diagnosis. It is a non-invasive and easy to use tool. It is particularly useful when child abuse is suspected, when examining dark skinned persons where hematomas can be confused with skin color, or even among obese persons where deep hematomas do not appear or only appear after a significant period of time on the skin surface.

The aim of forensic diaphanoscopy imaging is to facilitate the diagnosis of signs of violence on living adult, victims of aggression or abused children.

Clinical Forensic Medicine, Diagnostic Imaging of Trauma, Invisible Hematoma

G99 “Drop Dead”: An Epidemic of Intravenous Fentanyl Deaths in Cook County, Illinois: 2005 to Present

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The goal of this presentation is to understand that fentanyl has suddenly appeared as an intravenous drug of abuse, and that medical examiners, public health officials, and emergency physicians should realize that clusters of sudden death may appear as an epidemic of fentanyl intoxications.

This presentation will impact the forensic community and/or humanity by demonstrating the response of the medical examiners office to a sudden onset and ongoing epidemic of sudden unexplained death, subsequently found to be from illicit intravenous fentanyl abuse. This has implications for public health in monitoring and quickly diagnosing clusters of sudden unexpected death in an urban population.

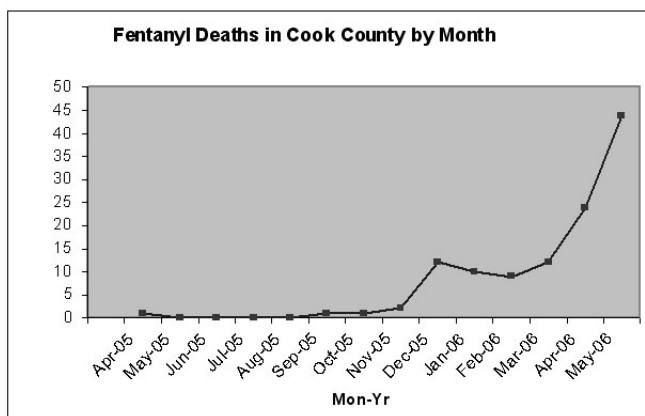
In November 2005 in Cook County, Illinois, an epidemic of intravenous fentanyl deaths began and quickly accelerated, and has not slowed as of June 2006. This epidemic of fentanyl intoxication in Cook County has not been previously described. Prior to 2005, fentanyl intoxication fatalities, or fentanyl-related deaths, in Cook County were almost exclusively from abuse or misuse of fentanyl transdermal delayed-release patches. Fentanyl is approximately 50 times more potent than heroin, and is a synthetic opiate used clinically during invasive medical procedures and for outpatient pain control through a transdermal patch delivery system. Some of the more unusual fentanyl intoxications in Cook County have been previously presented (Wu Chen, N, et al. Suicide by transdermal patch, AAFS abstract K19, Orlando, FL, 1999).

Cook County, Illinois, is a compact major metropolitan area of approximately 5.5 million people within an area of 950 square miles that surrounds and includes the city of Chicago. In December 2005 hospital emergency rooms began to report an increase of tight clusters of overdoses initially concentrated in the Near South Side of Chicago. In the emergency department setting, some of the survivors' urine toxicology testing results was positive for opiates from heroin, but some were not, even though all showed clinical signs and symptoms of a rapid acute opiate overdose. At the same time, fatalities occurring in these small clusters of apparent opiate intoxications were brought to the Cook County Medical Examiners Office for examination.

Death scene investigations and histories of these fatalities often showed a rapid collapse after the injection and the term “Drop Dead” was coined on the street to describe this new “tainted heroin.” The police used

the local media to warn the public about a deadly heroin product mixed with fentanyl. Syringes found next to the victims were sent by the Chicago Police to the Illinois State Police Crime Laboratory for rapid testing, revealing the presence of fentanyl. The fentanyl was purchased from street corner drug sellers as a white powder, in amount and consistency similar to heroin. Prior to this epidemic, fentanyl was not routinely tested for in the Cook County toxicology laboratory. A fentanyl testing protocol was begun for all suspected drug intoxication deaths after the epidemic was discovered, and then tested for retrospectively to September 2005.

Data of fentanyl intoxication deaths were retrospectively collected for the years 1995 through early 2006 from the Office's database. As numbers of fentanyl intoxications accelerated in 2006, data was collected and analyzed prospectively for entry into a real-time CCME Fentanyl Intoxication Database. For January 1995 to November 2005, the CCMEO averaged four cases per year (range 1 (1995, 2000) to ten (2002)). Criteria for certification for fentanyl intoxication deaths were similar to the office's criteria for opiate-related deaths. Intravenous fentanyl intoxication deaths from April 2005 through May 2006 are shown:



Fentanyl-related deaths initially appeared in November (2), accelerated in December (12), stabilized in January (10) and February (9), but then accelerated again through March (12), April (24) and May (44). Initial June data shows this upward trend is continuing. Of the fatalities from April 2005 through May 2006, 96 were male and 20 female. The average and median ages were 40 years, with a range of 16 to 61. The average concentration of fentanyl in postmortem peripheral blood was 23 ng/ml (median 17; range 0.9 to 134). These 116 fentanyl epidemic deaths through May 31, 2006, were further subcategorized as fentanyl intoxication without other drugs (43, 37%); fentanyl and opiate intoxication (20, 17%); fentanyl and cocaine intoxication (29, 25%); fentanyl, opiate and cocaine intoxication (6, 5%); fentanyl, opiate, cocaine and alcohol intoxication (3, 3%); fentanyl and alcohol intoxication (6, 5%); fentanyl, alcohol and opiate and intoxication (5, 4%); and fentanyl, cocaine and alcohol intoxication (4, 3%). This data shows that fentanyl is being sold in Chicago predominately as a single drug, not as a so-called “tainted heroin” product. But it also shows that fentanyl is being abused in combination with heroin or cocaine, although less frequently. Other drugs detected with fentanyl could either represent the purchase of a combined product, or the concurrent use of each individual drug. The origin of this illicit white powder fentanyl and the reason for its rapid and continued influx into the Chicago land area is currently under intense investigation by numerous government agencies.

Fentanyl Intoxication, Sudden Death, Cook County, Illinois

G100 Bidding for Poison: The New Availability of Poisons and How to Use Them

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After attending this presentation, attendees will have an awareness of the facilitative role of the Internet in obtaining and using deadly poisons and the impact this will have on forensic investigators, pathologists, toxicologists, and computer criminologists.

This presentation will impact the entire forensic community by highlighting the ease of access to deadly poisons and guidelines for lethal use on the Internet. In cases of an apparently negative autopsy and/or vague allegations of poisoning by family, the threshold of suspicion has been raised by almost universal access through the Internet. Strychnine, the poison inadvertently obtained for this study, should also be considered in unexpected death in athletes.

An online bid was placed on a collection of antique pharmaceutical bottles, some of which were known to have originally contained strychnine sulfate, and which were purchased for an extremely reasonable sum.

The bottles arrived by UPS Ground, left on the doorstep. While this seemed unusual at the time, the seller was clearly paying homage to the prohibition of sending toxins through the USPS. There were several bottles of strychnine sulfate, most of which unexpectedly contained the pure substance, a fact verified by the Toxicology office associated with the Office. The seller had no knowledge of the author's occupation or intent for the purchase. There was no communicated warning.

Strychnine has a long and colorful history, becoming available in the early 19th century as a "tonic" for people and a poison for pests (and, arguably, for people). It binds at stimulatory receptors in the central nervous system as well as the inhibitory receptors, resulting in a massive over-transmission of signals. Although caution has always been recommended with its use, the therapeutic applications were myriad and included impotence, alcoholism, constipation and prolapsed uterus. It may have had a limited clinical role in the treatment of surgical shock and congestive heart failure. It is to this day on the list of banned substances for athletes, having been implicated in the win of the 1904 marathon (along with raw egg and brandy, which carry their own risks). Eventually, of course, it was recognized that the risk far exceeded the therapeutic benefit and its use was abandoned. It is currently available to athletes as the herbal *nux vomica*.

It is hardly a perfect poison for homicide because of its bitter taste and short delay in causing respiratory muscle paralysis. Acute poisoning may be treated symptomatically. It is, however, one of the most potent poisons known and may be administered through multiple routes, including dermal. The horrific terminal phase of convulsions may be attractive to those with homicidal intent.

Strychnine is tightly regulated but widely available as a rodenticide. The latter would be particularly unpalatable in the volume required for homicidal intent. The safety recommendations for underground rodenticide use are comparable to biosafety standards for autopsy.

In his classic and arguably still relevant chapter on homicidal poisoning, Adelson cites both access and knowledge of use as prerequisites for the poisoner. Both are within reach of those accomplished in the use of the Internet.

A disturbing study was conducted by the California Poison Control System (Look what I found! Poison hunting on eBay, *Clin Toxicol* (Phila). 2005;43(5):375-9)). Over a 10-month period, 125 individual products too dangerous for commercial use were identified on online auctions; 24 were "supertoxic," including strychnine. Even a cursory search identifies guides to poisoning, including books in the popular press, some intended as a reference for crime novelists.

All medical examiners have undoubtedly had cases that were frustratingly negative for a cause of death. In addition, almost all have

likely had cases where relatives alleged poisoning, although no access or specific substance was implicated.

Medical examiners, previously protected by the obstacle of access to deadly poisons, need to lower their indices of suspicion for cases of poisoning. Courtesy of the Internet, access and knowledge of use are widely available. Not only must appropriate toxicological analysis be considered and performed but also law enforcement investigators with computer crime experience must be involved in a timely fashion.

Poison, Access, Internet

G101 Cluster of Fentanyl-Tainted Heroin Deaths in a Three-Week Period in Maryland

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After attending this presentation, attendees will understand the public health significance of cooperative efforts between the Office of the Chief Medical Examiner (OCME), the Maryland Drug Early Warning System (DEWS) at University of Maryland's Center for Substance Abuse Research (CESAR), the Maryland Poison Center (MPC), and the Maryland State Police (MSP) in the ability to detect a cluster of fentanyl-tainted heroin deaths in a short period of time.

This presentation will impact the forensic community and/or humanity by presenting the problems of detecting fentanyl by routine opiate screens and by emphasizing the importance of drug surveillance systems to detect emerging drug trends.

Fentanyl is a fast-acting, highly potent synthetic opioid agonist that is approximately 50-100 times more potent than morphine. Overdose effects occur rapidly and death occurs primarily from respiratory depression. Regional outbreaks of "super potent heroin" have been reported in the past. The outbreak in April and May 2006, of which this presentation is a part, included over 120 deaths in the Midwest, Northeast, and Mid-Atlantic regions. The primary markets included Chicago, IL, Detroit, MI, Philadelphia, PA, and Camden, NJ. In May 2006, authorities seized a fentanyl laboratory in Toluca, Mexico and this was the suspected source of the tainted heroin. A by-product of illicit fentanyl manufacture by the "Siegfried Method" is 4-Anilino-N-Phenethyl-Piperidine (4-ANPP).

Fentanyl is available by prescription as a transdermal patch, an oral lozenge and an injectable form. It is manufactured illicitly as powder or tablets. Fentanyl is abused in any of the prescribed or illicit forms. More creative forms of abuse include, wearing multiple patches, scraping the drug off the patches and snorting or injecting it, and chewing and/or swallowing the patches. Fentanyl is not detected using standard urine opiate immunoassays. As a result, negative tox screen results do not rule out a fentanyl overdose. Without performing a specific fentanyl immunoassay, the accepted detection methodology for the blood or urine is gas chromatography. However, detection can be problematic in that fentanyl is a late eluter and is usually present in very low concentrations. At the OCME, fentanyl was detected in the biological specimens following an alkaline extraction and analysis by gas chromatography-nitrogen phosphorus detection. Fentanyl was confirmed by full scan electron ionization gas chromatography-mass spectrometry (GC-MS). Fentanyl was quantitated by GC-MS, selected ion monitoring.

There were 15 fentanyl related deaths in the State of Maryland from 1/1/06 until the writing of this report and most were a result of the abuse of the patch. A cluster of five fentanyl-tainted heroin deaths occurred from

4/22/06 to 5/12/06. The MPC and CESAR initially reported to the OCME a series of 6-8 possible fentanyl-tainted heroin overdoses from the Eastern Shore of Maryland two days after the autopsy of the first suspected death. That individual survived for two days in the hospital where opiate confirmation was negative. Analysis of evidence from this scene by the local MSP crime lab revealed fentanyl and procaine. These results provided the first solid evidence that fentanyl was involved in this outbreak. At that time the OCME toxicology lab was alerted to look specifically for fentanyl. At a later date, the MSP crime lab also confirmed 4-ANPP in the same evidence. Thus far there are five confirmed fentanyl related deaths and three other suspected cases are currently under investigation. The age range of the deceased was 22 to 32 years old, four of five were Caucasian and four of five were male. Fentanyl concentrations ranged from 0.001 to 0.049 mg/L. One of five cases was positive for fentanyl only, three of five were positive for heroin, four of five had morphine in their system, four of five had cocaine in their system, and five of five scenes had intravenous drug paraphernalia. The areas of the state involved included Wicomico (1), Somerset (1), and Howard (1) counties, and Baltimore City (2).

Medical Examiner/Coroner's offices need to be aware of the limitations in detecting fentanyl and in cases where investigation points to a drug death and routine toxicology is negative, the toxicology lab needs to be informed of the possibility of fentanyl. A cooperative effort between the Medical Examiner/Coroner's offices and state drug surveillance systems is critical in order to detect emerging drug trends of public health significance.

Fentanyl, Heroin, Tainted

G102 Suicidal Caffeine Overdose

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After attending this presentation, attendees will learn of an approach to the evaluation of a multi-drug overdose suicide by history and presentation. Recognition of the symptoms and signs of caffeine poisoning in a case of suicidal overdose.

This presentation will impact the forensic community and/or humanity by recognizing the existence of the abuse of caffeine in a suicidal overdose, how to assess the signs and symptoms of caffeine overdose, and recognizing the signs and symptoms of other drugs when assessing a multi-drug overdose.

A 44-year-old woman with a history of eight previous psychiatric hospitalizations and multiple previous suicide attempts was brought to the emergency room by her daughter at 9:20 p.m. on the day before her death. Her daughter related that she had made a suicide attempt by taking a number of prescription and nonprescription pills.

She was alert when she arrived, but her daughter gave the history for her. She said her mother had taken large but unspecified amounts of Cymbalta (duloxetine, an antidepressant), Vistaril (hydroxyzine, an antihistamine with central nervous system sedative properties), Relacor (a dietary supplement chiefly composed of water-soluble vitamins and alleged to regulate fat metabolism and homocysteine production), Seroquel (quetiapine, an antipsychotic sometimes used as an antidepressant), and an over-the-counter diet medicine, Stacker 2 (a diet medication composed of camellia sinensis white and yellow leaf polyphenols, yohimbine alkaloids derived from *Pausinystalia Yohimbe* bark, 6', 7'-dihydroxybergamottin, capsaicin, and anhydrous caffeine [150 mg per pill]). It was believed that she might also have taken trazodone (an antidepressant medication commonly sold under the brand name Desyrel).

She accepted PO charcoal while she was still alert, but rapidly became unresponsive and went into respiratory failure, requiring emergent intubation. In short order, her hypotension became so profound that she required a dopamine drip. Her pupils were symmetrically dilated to 4 to 5 mm. An initial episode of pulselessness at 0005 AM resolved with cardiopulmonary resuscitative efforts. Levophed (norepinephrine bitartrate, a sympathomimetic vasoconstrictor) and dopamine were maximized to maintain a mean arterial pressure of 65 mm Hg. At 0153, she became pulseless again, and remained in pulseless electrical activity during resuscitation until 0217. She maintained a pulse for thirteen minutes, but became pulseless again at 0230; with the administration of 40 mg of vasopressin, she regained a pulse at 0233. Following this third cardiac arrest, with her pupils dilated and minimally reactive, the family requested full resuscitative measures be discontinued. She survived in that condition until her final cardiac arrest at 0726. She was pronounced dead at 0736.

At autopsy, she was a well developed, moderately obese (68", 220 lb) woman with pale conjunctiva, without congestion of the face and neck. Numerous dental caries were visible on limited examination of the oral cavity. An abdominal scar correlated with internal signs of a remote cholecystectomy and gastric bypass. There were no external wounds and no wrist scars. Internal visceral examination was significant only for diffuse fine renal cortical granulation in the absence of significant heart hypertrophy (heart weight 359 gm), and a 3" abdominal fat layer, measured 2" below the umbilicus. Two quarter-inch foci of subgaleal hemorrhage were identified, and a thin film of subarachnoid hemorrhage coated the left cerebral hemisphere and both occipital lobes.

Histologic examination showed evidence of old ischemic disease in the form of delicate, ramifying collagenous replacement of subendocardial myocardium, to a degree surprising for the gross exam of the heart. There was slight emphysematous change of the lungs, sclerotic glomeruli of the renal cortex, and superficial subarachnoid hemorrhage confirmed in the brain, without evidence of any arteriovenous malformation. No etiology for the subarachnoid hemorrhage was determined.

Toxicology performed on hospital admission blood was reported negative for trazodone, quetiapine, methamphetamine or byproducts, cocaine or byproducts, opiates, or alkaline extractable drugs. Ethanol was reported positive at 0.05% by weight by volume. Diazepam was present at a concentration of 0.07 mg/L without nordiazepam. Caffeine was present at the extremely high level of greater than 180 mg/L.

Caffeine poisoning is a rare cause of fatal overdose. Caffeine use is extremely widespread, to the degree that many toxicologic laboratories do not test for it in routine specimens. Caffeine toxicity without fatal poisoning is frequently reported. The signs and symptoms of fatal caffeine poisoning in light of this case, and, in comparison to opiates, cocaine, and antipsychotic and antidepressant drugs, will be discussed.

Discussion: Review of this cases will illustrate the forensic methods used to elucidate multiple drug death with overlapping signs and symptoms.

Suicide, Caffeine, Multi-Drug Overdose

G103 Abuse of Prescription Narcotics: A Look Beyond Prescription Monitoring Programs

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After attending this presentation, attendees will have a broader understanding of the widespread problem of prescription narcotic abuse. Additionally, the attendee will understand the liability of physicians, pharmacists and pharmaceutical companies with regard to the dispensing of schedule II narcotics. Finally, the attendee will be introduced to an alternative means to prescription monitoring programs for dealing with narcotic abuse.

This presentation will impact the forensic community and/or humanity by informing the forensic community of the ongoing problem of schedule II narcotic abuse in this country while offering an alternative to currently utilized prescription monitoring programs used in some states. This issue affects physicians, attorneys, law enforcement, and the community as a whole.

Prescription narcotics enable individuals to undergo surgery and relieve pain for millions of Americans who suffer from legitimate chronic pain. While millions of people suffer legitimately from pain, many others obtain prescription narcotics for illicit purposes. This non-medical use of prescription medications is a widespread problem and a serious public health concern. In order to combat the illegal use of prescription narcotics, many states have established prescription monitoring programs (PMPs). These programs collect data on the dispensing of certain narcotics from physicians and pharmacies and disseminate it to regulatory and law enforcement agencies. While these state run PMPs are an asset to the investigation of illegal narcotic use, various professional and special interest groups voice concerns about the application of prescription monitoring programs.

This presentation will offer an alternative to the prescription monitoring program after a discussion of the factors involved in dispensing prescription narcotic medications. An overview of narcotics and their potential use and abuse will be addressed, as well as sources of illicit prescription narcotics for abuse. The physician duty of care owed to patients being treated for pain will be discussed. Included in this section will be an overview of the widespread problem of the under-treatment of pain in the United States, as well as the serious consequences of prescription drug abuse in this country.

Deaths due to the use/abuse of prescription narcotics account for an alarming number of deaths in many areas of the country as evidenced by the autopsy results from Jefferson Parish, LA where in 2005, 22% of autopsy cases were due to the acute effects of drugs - many involving Schedule II narcotics often in combination and usually accidental. Additional data on these cases will be presented. A third component of this presentation will assess the duty owed to patients by pharmaceutical companies who manufacture prescription medications. This section will address the liability of drug manufacturers for failure to warn, as well as liability for negligent marketing. The duty of care owed by pharmacists to patients will also be discussed including the scope of the pharmacist's duty, in addition to recent developments in the approach to pharmacist liability.

An overview of current prescription monitoring programs will be provided with particular attention to issues of privacy and confidentiality of medical information. This section will also encompass the successes and limitations of these programs and federal initiatives regarding prescription monitoring programs. Finally, improvements to the current system of state prescription monitoring programs will be suggested including a proposed alternative method of addressing prescription drug abuse in the United States.

Narcotic, Prescription Monitoring Programs, Abuse

G104 Murder By Poison: Experiences of a Medical Examiner's Office

Christopher Swalwell, MD, Office of the Medical Examiner, 5555 Overland Avenue, Suite 1411, San Diego, CA 92123*

The goal of this presentation is to review the number and nature of homicidal poisonings encountered by the San Diego County Medical Examiner's Office during the last 20 years. The audience should gain a better appreciation of the complexities of investigating homicides resulting from poisoning and the circumstances and nature of such deaths.

This presentation will impact the forensic community and/or humanity through a better understanding of the types and frequencies of homicidal poisonings encountered in a large Medical Examiner's Office.

These experiences may be helpful in future investigations of murder by poisoning.

Despite the common portrayal of murder by poisoning in movies and television, deaths from homicidal poisoning are rare. Since the scene and findings can be subtle, the investigation of such deaths may be challenging. The purpose of this paper is to present the nature and findings of homicidal poisonings seen in a large Medical Examiner's Office over a period of 20 year. The San Diego County Medical Examiner's Office covers a population of approximately three million people.

Poison can be defined as a substance that causes injury, illness or death primarily by chemical means. As such, a poisoning could involve any type of chemical, drug or medication and could be ingested, injected, inhaled or even absorbed through the skin. The Medical Examiner's database from 1986 to 2005 was searched to identify all homicides that involved some type of poisoning, overdose or intoxication. This was done in several ways, including homicide queries for key words and visual scanning of the causes of death. Cases in which the cause of the death was not a direct result of a poison, medication or drug administered by another person were excluded. Also excluded were law enforcement restraint deaths and other deaths in which the victim was intoxicated or under the influence of a drug or medication at the time they were killed by other means. In addition, cases of fire related deaths and deaths in hospice patients given high doses of medications for end of life care were excluded.

During this time period, there were a total of 3601 homicides. Only 12 cases were identified that were the result of some type of drug, medication or chemical overdose or intoxication. This represents 0.33% of the homicides and is consistent with previous reports of 0.14 - 0.5%.

Homicidal poisonings in general will be briefly discussed, and the history and circumstances of the 12 cases will be presented along with the toxicologic findings. A variety of substances were used, and in some cases more than one agent was administered. The nature of the perpetrators and outcome of the cases will also be reviewed.

Homicidal poisonings are rare, but by their very nature tend to grab the attention of the public and news media. From an investigative standpoint they may be difficult to detect, and one may wonder how many cases are missed. These cases reveal a variety of circumstances, substances and perpetrators indicating that there is no stereotype for murder by poison.

Murder, Poison, Homicidal Poisoning

G105 Vaccine Death: A Rare Case of Anaphylactic Shock After Hexavalent Immunization

Stefano D'Errico, MD, Francesco Maria Morreale, MD, and Raffaella Bisceglia, MD, Institute of Legal Medicine, University of Foggia, Ospedali Riuniti, via L.Pinto 1, Foggia, 71100, Italy; and Rossi Giuseppina, MD, Institute of Legal Medicine, University of Siena, Policlinico Le Scotte, Siena, 53100, Italy*

After attending this presentation, attendees will learn of a rare case of fatal anaphylactic shock after hexavalent (against diphtheria, tetanus, pertussis, poliomyelitis, Haemophilus influenzae type B and hepatitis B) immunization in a three month-old female white infant is presented. The aim of the paper is to alert scientific community on reactogenicity of recent hexavalent formulation of vaccine.

This presentation will impact the forensic community and/or humanity by demonstrating that any death that occurs within a few days of vaccination to be autopsied using immunohistochemical stainings, toxicological analysis on urine and blood specimens and detection of femoral blood concentration of mast-cell Beta-tryptase to rule out anaphylactic shock.

This case presentation concerns a first-born child, delivered at the 41st week of gestation by caesarean delivery, with a birth weight of 3.400 g and Apgar scores of 9-10. The mother related no significant family history, an unremarkable pregnancy and good health of the baby, who was bottle-fed. At three months of age the female infant received a hexavalent immunization during a morning clinic visit. The mother stated that a few hours after the immunization the baby had difficulty feeding. Early in the afternoon the clinical condition of the baby got worse with the onset of severe dyspnea, so she was immediately taken to the emergency department of the local hospital. A state of shock with critical acute respiratory failure was diagnosed. The baby appeared pale and unresponsive. The baby was hypotensive (systolic pressure 50 mmHg) and tachycardic (180 bpm) with an undetectable diastolic pressure. Laryngoscopy was unremarkable. Laboratory tests revealed the presence of hyper-eosinophilia and metabolic acidosis (pH 7.154) with blood desaturation (pO₂ 75.9 mmHg) and compensatory hypocapnia. Repeated administrations of adrenaline by aerosol were given along with intramuscular corticosteroids. Despite the aggressive intervention the infant died two hours after arriving at the hospital.

A complete postmortem examination was performed two days after the death. External examination was unremarkable, except for the immunization puncture site on the left thigh. The body was of a three month old, well-developed and well-nourished, white infant with a body weight of 4930 gr and body length of 55 cm. Internal examination was unremarkable except for lungs presenting white foam in the main bronchi. Histological examination revealed mild cerebral oedema, and a shock histomorphology of the main organs (lungs, liver and kidneys). Immunohistochemical analysis revealed the presence of numerous degranulating mast-cells in the pulmonary parenchyma. Toxicological analysis of blood and urine specimens for therapeutic and non-therapeutic drugs were unremarkable. Postmortem measurement of mast cell β -tryptase in femoral blood was determined using the AA5 antibody ELISA; high concentrations, more than 10 ug/l were recorded (11.3 ug/l).

Adverse events following immunization are defined as medical incidents that take place after an immunization. Serious adverse events after vaccination have generally been defined as those adverse events that result in permanent disability, hospitalization or prolongation of hospitalization, life threatening illness, congenital anomaly or death. They are generally associated with the inherent properties of the vaccine (vaccine reaction) or some error in the immunization process (program error). The event could also be totally unrelated but only temporally related to immunization (coincidental event). The use of combination vaccines is an ideal way to simplify the simultaneous administration of multiple vaccines, reducing the number of injections, and may also be the most effective way of ensuring high compliance rates to complex immunization schedules. Recently, parental concern about polivalent vaccines has become increasingly prevalent. Hexavalent vaccine has been developed for primary booster vaccination of infants against diphtheria, pertussis, tetanus, poliomyelitis, Haemophilus influenzae type B and hepatitis B. Post marketing study confirmed the safety and immunogenicity of hexavalent vaccine as an alternative to other licensed vaccines. Members of the European Agency for the Evaluation of Medical Products in 2003 investigated whether there might be a link between hexavalent vaccines and some cases of sudden infant deaths occurred after immunization. It was concluded that there was no significant benefit/risk profile of these products, and, therefore, no changes in the present conditions of use were recommended. SIDS, viral infection, metabolic disorders, allergic reactions or airway obstruction were plausible but were not definitely proven to have been the cause of death. Vaccine associated anaphylaxis is a rare occurrence with only few cases reported despite the million of doses administered, giving a relative risk of 0.65 cases per million doses. It is not always clear which component of vaccine is involved in the anaphylactic reaction (antigens, preservatives, adjuvants, manufacturing residuals). Postmortem measurement of mast cell β -tryptase in serum is the only possible means of diagnosing or confirming death due to anaphylactic

shock because autopsy findings after acute anaphylactic death are generally non-specific; a cutoff value of 10 ug/l has been established to be optimal, with a sensitivity of 86% and specificity of 88%.

Hexavalent Vaccination, Mast-Cell Beta Tryptase, Anaphylaxis

G106 Pattern of Injury in Child Fatalities Resulting from Child Abuse

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After attending this presentation, attendees will understand some of the contributing factors and demographic characteristics in child fatalities due to abuse.

This presentation will impact the forensic community and/or humanity by assisting the forensic community/humanity in identifying key elements in maltreatment child fatalities.

When evaluating injuries in young children, physicians should consider nonaccidental trauma as an etiology of trauma. According to the U.S. Department of Health and Human Services, in 2002, an estimated 1,500 children died of maltreatment. Of these, 36 percent were as a result of neglect, 28 percent were victims of physical abuse, and 29 percent were due to multiple types of maltreatment. In 2003, children younger than four years old accounted for 79 percent of all maltreatment fatalities, with 44 percent of these deaths occurring in infants (DHHS 2005). The purpose of this study is to further examine the pattern of bony injuries in child maltreatment fatalities, with an emphasis on the prevalence of antemortem fractures and the presence of associated perimortem fractures. The sample was 130 male and female children, ages 0 to six years of age. The majority of the data were collected from the case files of the NC Child Fatality Prevention Team at the Office of the Chief Medical Examiner in Chapel Hill North Carolina (n = 120). An additional ten cases were included from the Charleston County Coroner's Office, Charleston, SC. Six age categories were used in this study: 1 (0 -3 months), 2 (4 - 6 months), 3 (7 - 9 months), 4 (10 - 16 months), 5 (17 months - 2 years), 6 (2 - 6 years). Each individual's lesions were documented and categorized into one of four general body loci (1 = craniofacial, 2 = thoraco/abdominal, 3 = other, 4 = multiple). The prevalence of trauma and distribution of injury patterns were tested for independence and significance for biological and demographic categories (e.g. age, sex, race, month of death) using simple frequencies and Chi-square tests. In this study, the peak age categories of death were 0-3 months (23 %) and two - six years (21.5 %), with 50 percent of deaths occurring in infants nine months old or younger. The two different age categories could reflect newborn stress and coincide developmentally with toddlers seeking independence, respectively. Black males were the most numerous victims. Deaths occurred most often in the month of December. The body locus most frequently affected was the craniofacial area, 55 percent, usually the result of blunt force trauma (abusive head trauma). Notably, ante- or perimortem fractures were not usually associated with known abuse deaths. In this study, eighty percent of the cases did not show any antemortem fractures. Thus in cases of suspected abuse, radiographic skeletal surveys may not be an effective method for identifying or predicting the possibility of abuse, which suggest that current detection techniques need to be reevaluated.

Child Abuse, Fatalities, Injury Pattern

G107 Histopathology of Antemortem Infant Bone Fractures: Estimation of Time Since Insult

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After attending this presentation, attendees will understand the gross, radiologic and histological signatures of antemortem (chronic) and perimortem (acute) infant bone fractures associated with child abuse and apply a general timetable to better estimate “time since insult” for wounds.

This presentation will impact the forensic community and/or humanity by providing a means of accurately dating antemortem fracture times, the pathologist and investigating team serving the pathologist can better pinpoint the association of a victim to suspect. This association (or lack thereof) will provide a date line to when wounds may have been received prior to death and help establish a history and pattern of abuse.

Autopsy protocols that allow only macroscopic and radiological evidence fail to provide adequate information about wound diagnosis and time since insult. The obvious importance of recognizing and evaluating evidence of this violence in cases of suspected child abuse is necessary to gain an appreciation a clear understanding of vulnerable bone, fracture site biomechanics and wound healing processes crucial to causation and response. Klotzbach and coworkers (2003) first qualified the radiological and histological signatures relevant to “time since insult” indicators and this research follows that protocol and the procedures of Marks and coworkers (2005) by expanding those diagnostic criteria of for microscopically qualifying and quantifying osseous apposition rates at various postmortem intervals. The rich cellular osteogenic environment characteristic of growing bone demonstrates a unique response when compared with static adult bone, regardless of location.

Twenty antemortem “healing” and five perimortem occult (hidden) and acute fractures from ribs and various appendicular bones from four infant victims were radiographically and histologically assessed for degree of bony response. The specimens were seized at autopsy and represent various stages of healing. All were prepared as undecalcified dry thin sections using normal petrographic methods. Both dissecting and light microscopy and SEM were utilized to document, diagnose/qualify and quantify defects.

Longitudinal and cross sections taken through wound sites reveal telltale structural remodeling correlating to chronology. These include the location and degree of woven “blastic” bone proliferation during conversion and obliteration of the comminuted byproducts of the hematoma soon after trauma, subsequent manifestation of the transformation of the initial solid callus into bone and finally, full mineralization and “clastic” remodeling of the callus. Besides recognition of these qualitative events, the ability to recognize, document and radiograph the wound at autopsy are described with a method for harvesting, processing for histology and the manner of embedding and sectioning for light and scanning electron microscopy. Finally, while validation of these results was performed using light and SEM, utilization is made by dissecting microscopy.

Like previous research, this study demonstrated a detailed continuum of bone healing in rib and diaphyseal fracture calluses and among diaphyseal surface woven bone proliferation. These data may imply one of three isolated or correlated scenarios: differential inter-bone response to similar forces causing breakage/trauma, differential wounding forces or chronological specificity in wound appearance.

Histology, Child Abuse, Bone Fracture

G108 The Likelihood of Inflicted Injury Is Better Evaluated by the Use of Inconsistent Histories With the Constellation of the Triad of Findings: Subdural Hemorrhage, Brain Swelling, and Retinal Hemorrhages

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After attending this presentation, attendees will learn the value of the use of inconsistent histories obtained by investigation as well as autopsy findings in determining the likelihood of inflicted injury in children.

This presentation will impact the forensic community and/or humanity by confirming that evaluating histories and autopsy findings is a reliable method of ruling in and ruling out many possibly inflicted injuries in children.

Hypothesis: The reliability of the methods used to identify inflicted injury deaths in children has been called into question in the global community. Reviewing a series of child deaths can test the use of the constellation of inconsistent histories with autopsy findings to diagnose such deaths.

Synopsis: Correctly distinguishing inflicted from inadvertent injury and from natural disease is critical to the criminal justice system. Certain patterns of injuries found clinically or at autopsy have been proposed to identify injuries inflicted on children. An observational study of the neuropathology of inflicted head injury in infants and children by Geddes et al in 2001 reported the frequent finding of: subdural hemorrhage, increased intracranial pressure, and retinal hemorrhages. Others have advocated use of this triad of findings to make the diagnosis of inflicted injury. A nursing education website asserts, “The triad of subdural hematoma, cerebral edema, and retinal hemorrhage represents a diagnosis of SBS (Shaken Baby Syndrome)”.

Histories have been important in identifying inflicted injury. Inquiry into the phenomenon of absent or fluid histories in the presence of subdural hemorrhages and extremity fractures led to the original recognition of battered children.

A study of 169 child deaths compared the patterns of ocular and systemic findings in children dying as the result of inflicted injury with those found in injuries from motor vehicle collisions, falls, and various asphyxial deaths and in natural disease. Inflicted injury was distinguished from accidental injury, undetermined causes, and natural disease by investigation of medical and social history, and circumstances surrounding collapse as well as autopsy findings.

The validity of using a limited subset of histories and a limited subset of autopsy findings (the triad) to identify inflicted injury was assessed using data from the study. The immediate causes of death included: 76 (45%) intentional injuries, 36 (21%) inadvertent injuries, 47 (28%) natural causes, and 10 (6%) undetermined causes.

The triad of findings of subdural hemorrhage, brain edema, and retinal hemorrhages was seen in 47 of the total 76 (62%) inflicted injury deaths and in eight accidental deaths of the total 36 (22%). The triad was not seen in any of the 46 natural deaths or any of the 10 classified as undetermined deaths.

The sensitivity of finding inconsistent histories with the presence of the triad was 80%. The negative predictive value of finding a consistent history when the triad was absent was 88%. The relative risk of the triad being found with an inconsistent history was 4.56 with confidence limits of 2.53-8.20 and a P-value << 0.01.

Finding the triad with more than one injury history showed good sensitivity (85%). The negative predictive value of the finding was 87%. The relative risk of the presence of the triad with more than one injury history was 3.49 with confidence limits of 1.77-6.90 and a P-value << 0.01.

In these subsets, consistent histories included confessions as well as impartial information about events preceding injury. Specificity in these cases was 69% and the positive predictive value was 56%.

Similarly, certain unusual “multiple histories” became clear when further investigated. Since “more than one history” was used in defining the subset, these unusual cases yielded a calculated specificity of only 48% and positive predictive value of 44%.

Summary: Subsets of histories and autopsy findings can be reliably used to identify deaths which are more likely to be the result of inflicted injury - deaths with an inconsistent history and the autopsy findings include the triad of subdural hemorrhage, brain edema, and retinal hemorrhages. With a consistent history and no triad, inflicted injury is unlikely. With an inconsistent history, or multiple histories, and the presence of the triad, inflicted injury is likely. Thorough investigation and complete autopsy findings must be used to establish whether or not a particular child’s death was caused by inflicted injuries.

Triad (SDH, Brain Edema, RH), Inflicted Injury, Retinal Hemorrhages

G109 Compressional Asphyxia Due to Prone Restraint Hold in a Child

Robert F. Corliss, MD, Andrew M. Baker, MD, and Kathryn K. Berg, MD, Hennepin County Medical Examiner’s Office, 530 Chicago Avenue, Minneapolis, MN 55415*

After attending this presentation, attendees will learn the dangers of prone restraint with compression, particularly in children, and how to approach the autopsy and investigation of such cases.

This presentation will impact the forensic community and/or humanity by helping forensic scientists question the role of prone restraint for behavior modification in children and consider alternative restraint procedures and monitoring for combative children.

This presentation reports a case of compressional asphyxia due to a prone restraint maneuver that occurred in a day treatment facility for children with behavioral problems. The decedent was a 7-year-old female with a history of aggressive behaviors since the age of two. She was enrolled in the treatment facility for approximately one month, during which time several disciplinary actions, including prone restraint, were employed for behavior modification. During extended prone restraints, staff noticed she would appear to “fall asleep” after calming down, but was easily awoken. On the day of the fatal restraint, she was displaying improper table manners and reportedly “gargling” her drink during lunch. After repeatedly ignoring staff requests to cease the behavior, she was taken for a five minute “cool-down” in a separate room. She became aggressive, and was placed in a prone restraint control hold on the floor. A small towel was placed under her head and two staff members employed the restraint with one laying across the calves and holding the left wrist, with the other staff semi-prone across the back controlling the right arm and torso and monitoring the head.

The two staff initiating the restraint were each relieved by another staff member at different times. The entire restraint was longer than an hour. The second staff controlling the torso was a 240-pound male who relieved his co-worker 30 minutes into the restraint. He noticed the child to be combative and resisting when he took over. The child claimed she needed to use the bathroom, and that she felt like she was going to throw up. It was apparently not uncommon for restrained children to make such claims, and this child had recently vomited during a previous prone restraint. The restraint continued uninterrupted, and the child calmed down, apparently falling asleep. It was noticed that she had urinated in her pants. After a reported period of about 30 minutes of no resistance, the staff began processing the release. The child was not responding, and when turned over she appeared blue around the mouth and lips. Resuscitative efforts were employed, and the child was air lifted to a

children’s hospital from the local emergency room. She showed no neurological recovery and was removed from life support approximately 50 hours following the restraining incident.

At autopsy a 67 pound, normally developed female child was examined. A recent abrasion to the left face and healing abrasions to both knees were seen. Serosal petechiae of the thymus and hilar visceral pleura were present. An area of localized intra-abdominal serosal hemorrhage involved the mid transverse colon, distal stomach and pancreas with intrapancreatic extension. These findings were interpreted as possible manifestations of compressional force, but may have resulted from aggressive or misguided resuscitation. Early bilateral bronchopneumonia was also identified.

Deaths during prone restraint are generally associated with police custody, with elements of excited delirium or illicit drug toxicity as potentially contributing factors. The importance of this case lies in the fact that the restrained was a child, with significant weight and size disparity from the restrainers. This restraint protocol placed significant weight over the torso of the child, and did not allow adequate visualization of the face to monitor breathing and consciousness.

Prone Restraint, Compression, Asphyxia

G110 Combined Types of Violence in Child Abuse: Report of Three Cases

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After attending this presentation, attendees will learn how different types of injury and neglect may contribute to child death in abuse, evaluate the differential contributions of neglect and battering in child homicides, recognize two or more distinct contributing causes to death in child homicide, and evaluate impact of such recognition on courtroom testimony.

This presentation will impact the forensic community and/or humanity by demonstrating overlapping and concurrent types of injury contributing to death in cases of child abuse, assessing relative contributions of injury and neglect in child homicide, and considering judicial outcomes and defense strategies in child homicides due to combined types of injury.

Forensic autopsy on battered children often identifies characteristic findings such as evidence of head impact with and without shaking, beating with and without patterned injury, fractures of ribs and long bones in various stages of healing, liver lacerations and other visceral injuries, and burns. Forensic autopsy on neglected children frequently reveals starvation, untreated medical illnesses, growth retardation, and dental caries. Neglect may also be diagnosed at autopsy when a caretaker has allowed a child to suffer injury through inattentiveness, such as when an unwatched child drowns.

The concurrence of neglect and battering is less common. This case series presents two children who came to forensic autopsy because of a combination of fatal neglect and fatal injury on the part of caretakers, and one child whose fatal injuries were due to two unusual overlapping kinds of violence, smothering and shaking/impact. Defense strategies and judicial outcomes for these cases are reviewed.

Case 1. Drowning and battering. A 3-year-old girl was left alone in a bathtub filled with water for what the mother described as ten minutes. The mother stated that the girl was underneath the water when she returned, lifeless. Emergency medical services found the child lying on a couch in the livingroom, with a large amount of water on the couch. The

girl had numerous bruises, lacerations, and abrasions over the back, chest, and extremities. Autopsy showed pulmonary edema with abundant froth in the tracheobronchial tree, supportive of drowning. There were also healing fractures of the left clavicle and of a left rib, and numerous scars of the head, trunk, and extremities; some of the wrist scars were due to ligatures. Malnourishment was diagnosed by the weight (less than 5th percentile for a normal girl of the same age) and height (less than 25th percentile), with a weight-to-height ratio less than the fifth percentile. Death was certified as due to drowning, with the manner homicide.

The mother was charged with felony second-degree murder in the setting of felony child abuse and neglect. Defense strategy included the argument that there was no connection between the abuse and the drowning. The mother was convicted. At the time of conviction, she was pregnant. The sentence of 16 years reflected the judicial decision to maintain her incarceration until all her five surviving children (including the fetus) should grow up.

Case 2. Smothering and shaken impact. His father found a 23-month-old boy dead in his bed, with obvious injury to the face and abdomen. The child had been in the care of his girlfriend before he was put to bed. Autopsy showed that the child had severe blunt force trauma to the head, torso, and extremities. This included bilateral subdural hematomas with retinal hemorrhages and optic nerve sheath hemorrhages, consistent with shaking, and multiple subgaleal hemorrhages and a brain contusion due to impact. There were multiple contusions and abrasions of the abdomen, including patterned injury, with contusions of the bowel and contusions and laceration of the mesentery, and right perirenal hemorrhage. There were multiple abrasions and contusions of the extremities without fractures. However, there was also evidence of smothering, including abrasions and contusions of the face, chin, and lips, and petechiae of the conjunctiva, face, scalp, and oral mucosa. Death was certified as due to acute blunt force head injury and asphyxiation from smothering, with the manner homicide.

The girlfriend was charged with felony child homicide. Defense strategies included the allegation that the caretaker was not the batterer, but that the child's 21-year-old developmentally challenged brother had fatally injured him during rough play on the floor; and that if the defendant had smothered him accidentally against her clothing, she had done so while holding a fatally battered child. The defendant was found guilty. The brother was not charged. Sentencing is pending at the time of this abstract.

Case 3. Starvation (neglect) and battering/shaking. An 8-week-old infant girl was found dead in her crib. A history was given that she had not been eating well for three weeks, but there had been no contact with medical professionals since birth. At autopsy, the child was dehydrated and severely malnourished (autopsy weight 5 lbs; birth weight 7 lbs 10 oz). The eyes were sunken, and the contour of the ribs was visible through the skin. The thymus had atrophied. The gastric pouch was empty, the duodenum and small bowel were nearly empty of chyme, and there was very little stool in the colon. There were bruises of the right forearm and left elbow, and on internal examination, there were multiple rib fractures in varying stages of healing. Examination of the head revealed multiple subgaleal hemorrhages, a linear right parietal skull fracture, and multifocal subdural hematomas of varying ages overlying recent and old brain contusions. Histology showed a dense neutrophilic inflammatory response in the subdural hematomas and the meninges of the brain and spinal cord, and multiple autopsy cultures grew out a single organism, *Salmonella arizonae*. Death was certified as due to meningitis, due to infected subdural hematoma, due to inflicted traumatic brain injury, with starvation contributing; with the manner homicide. The mother pled guilty. Sentencing is pending at the time of this abstract.

Review of these cases will illustrate the forensic methods used to elucidate multiple overlapping types of injury and neglect that may contribute to complex cases of child homicide.

Child Abuse, Child Neglect, Combined Types of Violence and Injury

G111 Brainstem Axonal Injury and Retinal Hemorrhages as a Substrate for Sudden Death in Second Impact Syndrome: A Case Report

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After attending this presentation, attendees will gain an assessment of central nervous system at autopsy for axonal injury, and globes at autopsy for retinal hemorrhage.

This presentation will impact the forensic community and/or humanity by increasing the awareness of the pathology and pathophysiology of so-called second impact syndrome. Moreover, it will raise the much needed concept that retinal hemorrhages, while a useful "marker" of abuse, are not diagnostic of abuse, and that a degree of circumspection is required in assessing accidental vs. nonaccidental trauma in children.

Second impact syndrome is an ill-defined syndrome in which presumably trivial head injury, following a concussion or other significant head injury is associated with sudden death. The pathophysiology of this process is unclear, although diffuse cerebral swelling has been implicated.

An 18-month-old boy who suffered a closed head injury from fall from a balcony, following which he underwent a short period of rehabilitation and was discharged with a helmet. The helmet was prescribed because the child's motor skills had slightly deteriorated. Four weeks following the fall from the balcony, the child suffered a fall from a coffee table witnessed by both a parent and another adult, after which he immediately became unresponsive and expired several days later with cerebral swelling and nonperfusion. He was not wearing the helmet at the time of the fall from the coffee table. At autopsy, marked edema with diffuse bilateral ischemic necrosis was present throughout the cerebrum, cerebellum, and brainstem. In addition, the right lateral brainstem as well as the corticospinal tract at the pontomedullary junction showed axonal shear injury, including numerous swollen axons and microglial activation that were temporally consistent with the initial closed head injury. Bilateral retinal hemorrhages and bilateral optic nerve sheath hemorrhages were also present. This case demonstrated that this subject may have been predisposed to sudden decompensation following trivial head injury because of pre-existing brainstem axonal injury and a vulnerable brainstem cardiorespiratory center. Close examination of the brainstem for evidence of axonal injury is warranted in subjects who expire following trivial head injury, especially in the case of previous head injury. This case further highlights the lack of specificity of retinal hemorrhages in terms of accidental vs. non-accidental trauma, and that careful assessment of individual cases is necessary before concluding injuries were inflicted by another.

Second Impact Syndrome, Axonal Injury, Retinal Hemorrhage

G112 Sexual Abuse: Hymenal Findings in Girls With a History of Vaginal Penetration

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After attending this presentation, attendees will understand that hymenal lesions at colposcopic examination are seldom seen in late disclosure of sexual abuse in children with vaginal penetration.

This presentation will impact the forensic community and/or humanity by assisting professionals in understanding that hymenal lesions are seldom seen in sexually abused girls who report vaginal penetration.

The Institute of Forensic Medicine, University of Aarhus, at the request of the police, performs colposcopic examination of children suspected of being sexually abused.

From January 1, 1996, to September 2002, 482 children living in Jutland, Denmark, were investigated (1.48/10,000 children from birth to 16 years).

This study focuses on hymenal findings in cases of a history of vaginal penetration given either by the child or by the perpetrator or both.

Results: Two hundred twenty-six girls reported vaginal penetration at least once, and of these 116 were penile penetration.

The median age of the girls was 12 years (range 2-14 years).

Forty-nine girls (22%) were examined within 24 hours after the last sexual assault, 27 (12%) less than a week and 116 (51%) more than a week later; and in 34 cases (15%) the time since the alleged penetration was unknown.

The hymen was normal in 155 girls (55%), showed erythema in 18 (8%) and lesions in 20 (9%); the rest had other irrelevant findings or were unknown.

Hymenal clefts were found in 50 girls (25%), but only 17 girls (38%) had a complete hymenal cleft and of these 15 were above 12 years of age (median age 14 years). In a nine-year-old girl an anteriorly located cleft was observed.

The incidence of hymenal clefts (both incomplete and complete) in the 426 girls investigated increased with increasing age. Thus, 78% of the clefts were found among the oldest girls (above 11 years).

Eight of the girls with a hymenal cleft had used tampons on a regular basis. One hundred and nineteen cases were prosecuted and of those 102 suspects (86%) were convicted. Eight perpetrators admitted vaginal penetration, and the victims in these cases all had a complete posterior hymenal cleft.

No significant correlation was found between hymenal clefts and appearing at court or being convicted, nor between complete clefts or conviction at court.

There was, however, a relationship, although non-significant, between the age of the girls and the probability of the perpetrators to appear at court; the age of the girls in cases resulting in a conviction was significantly higher than in those resulting in acquittal ($p=0.02$).

Conclusion: In cases of late disclosure of sexual abuse, the history from the child and the perpetrator, not physical findings, remains the single most important feature in evidence of sexual abuse.

Child Sexual Abuse, Vaginal Penetration, Hymenal Lesions

G113 A Chest Full of Blood: Hemothorax as a 26 Year Delayed Consequence of Repair of Transposition of the Great Vessels

Karen B. Looman, DO*, and Wendy M. Gunther, MD, Tidewater Office of the Chief Medical Examiner, 830 Southampton Avenue, Suite 100, Norfolk, VA 23510

After attending this presentation, attendees will learn about an uncommon consequence they may see long after surgical correction of transposition of the great vessels.

This presentation will impact the forensic community and/or humanity by providing useful information about a potentially lethal delayed complication of a common surgical procedure to correct a congenital heart problem; describing newer procedures that do not have this kind of problem; and illustrating signs and symptoms to look for in a similar autopsy case.

A 27-year-old woman had been born with transposition of the great vessels (TGV), a congenital heart disorder that was always fatal before corrective surgery was developed. In TGV, blood oxygenated by the lungs never reaches the rest of the body, and blood returning from the body never reaches the lungs. This occurs because, in TGV, the pulmonary artery is attached to the left side of the heart and the aorta is attached to the right side of the heart.

Twenty seven years ago, a standard treatment for this disorder was the Mustard procedure, in which the pulmonary veins are detached from the left atrium and surgically reattached to the right atrium, and the superior and inferior vena cava are detached from the right atrium and reattached across an "atrial baffle" to the left atrium. This procedure allows oxygenated blood to flow to the body, and deoxygenated blood from the body to return to the lungs. It also allows the coronary arteries to remain in their native position in the aorta. It has the disadvantage that the right ventricle is responsible for pumping blood to the body, which causes it to hypertrophy, and the left ventricle pumps blood to the lungs, under too much pressure.

The patient's Mustard procedure was performed at 11 months of life. She recovered well and lived for twenty-six more years. Approximately three months prior to her death, she was diagnosed with pneumonia, and was treated with antibiotics. The day before her death, she complained of chest pain. The night of her death, while talking on the phone, she had a fit of coughing. The expectorant contained blood. She went to the emergency room, and during the initial work-up, collapsed and died.

At autopsy, external examination revealed a slender, gracile and nearly cachectic female who had pallor of the face and body. There was a midline chest scar as evidence of her previous cardiac surgery, but no recent injuries or surgical procedures. Blood for toxicology was hard to obtain by inguinal or subclavian puncture.

Internal examination revealed a right hemothorax with 1700 cc of blood and clots, visceral pallor, and depletion of the vascular tree. The heart showed evidence of the Mustard procedure, with all anastomoses intact. However, there were bilateral pulmonary artery aneurysms. The right ventricle showed evidence of extreme hypertrophy, with the wall measuring up to 1.5 cm thick. The right pulmonary artery showed a 10 cm aneurysm at the hilum that extended into the lung. The left pulmonary artery revealed a 3cm aneurysm. A fresh rupture was found in the right pulmonary aneurysm near the hilum, creating the hemothorax and causing the young woman's death.

Extensive recent and older thrombosis of pulmonary artery branches leading from the aneurysm into the right lower lobe was noted, suggesting this might have prompted the diagnosis of pneumonia. Thrombosis of these vessels might have been responsible for raising the pressure in the aneurysm, ultimately leading to rupture.

The Mustard procedure has been known to extend victims' lives for ten years or more. However, pulmonary artery aneurysms, although rare, have been reported in the literature as a long term sequela. Commoner

problems with the Mustard procedure include cardiac arrhythmias and baffle leaks. Transposition of the great vessels is now treated by a different procedure, the arterial switch.

This case report will compare the long term complications and advantages of the arterial switch to the Mustard procedure in light of this catastrophic delayed result. This will aid forensic personnel in the future when they have a case for forensic autopsy with a history of surgical repair of transposition of the great vessels. They will know what to expect on heart dissection from these surgeries, and to anticipate the possible long term problems that can accompany these types of techniques.

Transposition of Great Vessels, Aneurysm, Sudden Death

G114 Suicidal Hanging of a Postpartum Woman Who Discontinued Anti-Depressant Medication During Pregnancy

Gregory L. Hess, MD, Jeffery M. Jentzen, MD, and Russell T. Alexander, MD, Milwaukee County Medical Examiner Office, 933 West Highland Avenue, Milwaukee, Wisconsin 53233*

The goal of this presentation is to review a case of postpartum suicide in a woman with a history of major depression who discontinued her psychotropic medications during the first trimester of her pregnancy. The current controversies surrounding the treatment of depression during pregnancy and in the postpartum period will be reviewed.

This presentation will impact the forensic community and/or humanity by discussing the risks and benefits of treating depression in the puerperal period.

The decedent was a 30-year-old female who hanged herself with a dog leash 45 days after the uncomplicated vaginal delivery of her third child. Three days prior to death she began expressing depressive symptoms reported as sleep disturbance, restlessness and obsessive preoccupation with her youngest child. The day before her death she sought medical attention at a local walk-in clinic for depression and was prescribed sertraline (Zoloft). The next evening she fashioned a noose from a dog leash and using a cut log as a step stool, fully suspended herself by the neck from a tree in the back yard of her home. Scene investigation revealed copious emesis in the kitchen trash, and an empty bottle of sertraline.

She had a history of two previous inpatient hospitalizations for major depression, the first of which was an involuntary hospitalization manifested by self induced starvation and dehydration. During the first hospitalization, five years prior to her terminal event, she tried to hang herself by her bra strap three times. A second depressive episode, approximately one year before her suicide, was punctuated by her threatening to kill herself with a kitchen knife. Neither of these depressive episodes appeared related to her prior pregnancies. Her psychiatric medications prior to her third pregnancy consisted of sertraline and quetiapine on which her symptoms appeared well controlled. She discontinued her medications during the first trimester of the last pregnancy in consultation with her obstetrician secondary to the unknown teratogenicity of these medications (both are pregnancy category C). She had not restarted her medications immediately after delivery because, according to her husband, she had not felt depressed and she was breastfeeding.

At autopsy a dried ligature abrasion partially encircling the neck crossed the neck anterior midline over the superior edge of the thyroid cartilage. No petechiae were identified on the conjunctivae of the eyes, facial skin, lips or oral mucosa. A layer-wise anterior neck dissection did not reveal hemorrhage or injury within the strap muscles of the neck, the hyoid bone, or the thyroid cartilage. No pill fragments were found in the stomach. Postmortem toxicology testing revealed an elevated level of sertraline (0.24mg/L), but no additional drugs or alcohol in iliac blood.

Approximately 10% of women develop depression during pregnancy or in the postpartum period, and a previous history of major depression is a risk factor. The previous held belief that pregnancy offers "protection" from major depression has been challenged by a recent study showing a significantly higher rate of relapse amongst women who discontinued anti-depressant medication compared with those who continued treatment (Cohen et al., 2006). Selective serotonin reuptake inhibitors (such as fluoxetine, sertraline, and paroxetine) have been recommended for the treatment of depression during pregnancy due to their efficacy, as well as historical data suggesting they are not associated with birth defects (Kahn et al., 2001). Although sertraline is the most commonly prescribed anti-depressant in breastfeeding women, controversy still exists over the adverse effects it exerts on breastfed infants of mothers taking this medication (Gentile, 2005; Whitby and Smith, 2005). Concerns of fetal teratogenicity and infant toxicity due to intrauterine or breast milk exposure to anti-depressants must be balanced against the documented adverse effects that pregnancy related depression imparts on fetal and infant outcomes (Bonari et al., 204; Mian, 2005). A rare though dramatic outcome of pregnancy related psychiatric illness is maternal suicide or infanticide. Postpartum psychosis affects approximately 1% of women and may increase the risk of maternal or infant death.

This case presentation highlights the risk of discontinuing anti-depressant therapy during pregnancy for a woman with a history of major depression and previous suicide attempts. Medical examiners and investigators need to seek out a history of discontinuation of psychiatric medication in women who kill themselves or their children during pregnancy or postpartum. Only by being aware of the current controversies surrounding the treatment of depression during pregnancy and in the postnatal period will medical examiners be able to offer informed opinions when suicide or infanticide occurs in these settings.

Pregnancy, Depression, Suicide

G115 A Simple Model for Teaching Postmortem Monocular Indirect Ophthalmoscopy

Terrill L. Tops, MD, and Patrick E. Lantz, MD, Wake Forest University Health Sciences, Department of Pathology, Medical Center Boulevard, Winston Salem, NC 27157*

After attending this presentation, attendees will understand the enhanced potential for skill acquisition in postmortem monocular indirect ophthalmoscopy using a simple and inexpensive model simulating the ocular fundus.

This presentation will impact the forensic community and/or humanity by demonstrating a teaching model that can be used to enhance skill acquisition in postmortem monocular indirect ophthalmoscopy and be assessed to accurately identify and describe fundal abnormalities of pathological significance such as retinal hemorrhages.

Postmortem examination of the fundus oculi has relied on direct ophthalmoscopy or ocular evisceration, but recently the techniques of postmortem ophthalmic endoscopy and monocular indirect ophthalmoscopy have been delineated. Direct ophthalmoscopy has been used to attempt estimates of postmortem interval and identify retinal abnormalities but its usefulness is hindered by postmortem corneal clouding (swelling), inherent limited field of view, an inability to view the peripheral retina and lack of stereopsis. In most medical examiner/coroner jurisdictions ocular enucleation is not a standard autopsy procedure unless child abuse is suspected, thus invariably inuring observational bias when citing the prevalence of certain fundal findings (e.g., retinal hemorrhages). Postmortem endoscopic funduscopy permits viewing and documentation of retinal abnormalities; however, the equipment is costly and training necessary to gain expertise in operating the endoscopic equipment and subsequent image acquisition. The material necessary for postmortem monocular indirect ophthalmoscopy (PMIO) is inexpensive and when

compared to direct ophthalmoscopy the technique is less affected by corneal clouding, cataracts, or vitreous hemorrhage. Other advantages include a relatively large field of view, high resolution and an ability to visualize the peripheral retina. Disadvantages include low magnification and a projected aerial image that is inverted and laterally reversed.

A valuable skill for forensic pathologists, the technique of postmortem monocular indirect ophthalmoscopy can be challenging for pathology residents and forensic pathology fellows to master. Indirect ophthalmoscopy is not routinely taught in most medical schools so with the exception of ophthalmologists-in-training most residents and fellows have a limited exposure to the technique. Because the projected aerial image is inverted and laterally reversed precise descriptions or recording of fundal abnormalities can be challenging. Since the image cannot be viewed simultaneously by the instructor and student, learning PMIO can be intimidating because the more experienced forensic pathologist must teach the technique and describe the orientation of any fundal abnormalities observed.

To facilitate skill acquisition in PMIO, a simple and inexpensive teaching model can be constructed from hinged, cylindrical plastic containers having an internal diameter of 35 mm and a depth of 30 mm. A 9-mm hole drilled in the center of the hinged lid from a 1-oz cylindrical plastic canister creates an artificial pupil. Fundal images depicting hemorrhagic retinopathy printed on 8 x10-inch matte photographic paper are cropped into 3.5 mm circles with available imaging software. Trimmed images from the photographic paper are fitted into the canister's base. The lid of the canister marked as to the appropriate eye and correct orientation completes the model. Using a procedural headlight and an aspherical indirect condensing lens, the resident or fellow can practice viewing the simulated fundal image. Multiple fundoscopic abnormalities with retinal hemorrhages can be created for teaching with variations in the number, location (preretinal, intra-retinal, subretinal), distribution and orientation relative to the optic disc. Using this simple teaching model, the pathology resident or fellow can be assessed as to his/her ability to accurately identify and describe the number, location, distribution and orientation of retinal hemorrhages and various other fundal abnormalities of pathological significance.

Postmortem Monocular Indirect Ophthalmoscopy, Ocular Fundus, Retinal Hemorrhage

G116 A Case of Fatal Water Intoxication in a Toddler

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After attending this presentation, attendees will have reviewed the physical and chemical signs and symptoms of water intoxication, thereby broadening the differential diagnosis in cases of sudden death particularly in pediatric practice.

This presentation will impact the forensic community and/or humanity by demonstrating the clinical signs and symptom of water intoxication as well as the differential diagnosis of this condition so that it might be a consideration in cases of sudden unexpected death particularly when environmental conditions include exposure to water.

This presentation concerns a case of fatal water intoxication in a toddler after a day of swimming and a review of the literature on pediatric water intoxication.

A 2.5-year-old, 12 kg, previously healthy female presented to a community emergency department with profoundly altered mental status. Her caregiver reported the child had been at a home pool for several hours

and on leaving had been “fussy” and may have fallen “onto her bottom” on the way to the car. She had one episode of copious clear emesis. Immediately after this she became progressively lethargic and unresponsive.

On presentation to the emergency department, her vital signs (HR 67, RR 35, O₂ saturation 64% on room air, BP 145/84) were consistent with Cushing's triad. She was emergently intubated and her vital signs normalized. Neurological exam revealed response only to painful stimuli. Her pupils were sluggishly reactive. Initial laboratories (prior to administration of any fluids) revealed a serum Na⁺ 128, Cl⁻ 95, K 3.3, CO₂ 15, BUN 15, Cr 0.2, and Glc 259. A bolus of 400cc of normal saline was ordered and transfer to a tertiary care pediatric hospital was arranged. Inadvertently, a bolus of D5W was reportedly administered instead of normal saline.

Initial labs at the tertiary care facility revealed a serum Na⁺ of 120. Her pupils were fixed and dilated and she had no respiratory effort. Physical exam was normal with the exception of her neurological exam and specifically did not reveal any evidence of rashes or signs of trauma. Her neurological exam revealed she had no doll's eye reflex, corneal response, cough or gag. She did withdraw minimally to painful stimuli. An emergent head CT demonstrated diffuse cerebral edema with herniation and no radiological evidence of intracranial hemorrhage, although the differential diagnosis included trauma. She was admitted to the Pediatric Intensive Care Unit and fluid resuscitation was initiated. Within hours she developed central diabetes insipidus, with high urine output (8 cc/kg/hr), urine specific gravity of 1.000, and a rapidly increasing serum sodium (maximum Na⁺ 155), despite changing intravenous fluids to 0.45 normal saline. Vasopressin therapy was initiated. Ophthalmologic examination ten hours after initial presentation showed splinter retinal hemorrhages in the posterior poles bilaterally. Over the next three days, her neurological exam deteriorated until she no longer withdrew to painful stimuli. At that time, her family elected to withdraw life support. A postmortem skeletal survey was negative for fractures.

The case fell under the coroner's jurisdiction and a forensic autopsy was ordered. At autopsy, no external signs of trauma were identified. Her thoracic and abdominal cavities were normal with the notable exception of cardiomegaly (76 g) and splenomegaly (90 g), neither of which were noted pre-mortem. Cranial contents were consistent with diffuse cerebral edema and uncal herniation without intracranial hemorrhage. Cerebral spinal fluid collected using sterile technique was noted to be xanthochromic and somewhat gelatinous but not frankly purulent. Culture of the CSF grew *Klebsiella pneumoniae* in the broth only. No organisms were identified on gram stain of the CSF.

Local law enforcement officials conducted an investigation including interviews of all parties who had had contact with the child. Her adult caregivers on the day of her presentation reported that she had been in a floating toy in a backyard above ground pool for several hours during the day. Both adults present at the time did not recall the child becoming submerged at any time. One caregiver indicated that the adults and older children present at the pool had been jumping in from the edge creating “tidal waves” repeatedly. Repeated interviews with the caregivers revealed consistent histories of the events of the afternoon.

The cause of death was cerebral edema due to hyponatremia due to acute accidental water intoxication. The manner of death was determined to be accidental.

A review of the English language literature on accidental water intoxication reveals five cases in the pediatric population with symptoms similar to this case. With timely, appropriate fluid resuscitation a full recovery is possible, even when the presentation includes a comatose state. It is most likely that this child swallowed a large volume of pool water, which acutely dropped her serum sodium that resulted in her symptoms, with subsequent irreversible cerebral edema and herniation.

Water, Intoxication, Pediatric



H1 A Histological Examination of *Odocoileus virginianus* for Forensic Application

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37996-0720

After attending this presentation, attendees will understand the applications of bone histology in forensic settings as well as the importance of the histological character of non-human remains (*Odocoileus virginianus*) to successfully differentiate them from fragmentary human remains.

This presentation will impact the forensic community and/or humanity by demonstrating how the development of a histological database for nonhuman species will aid forensic investigations by providing a comparative standard to more accurately determine the identity of fragmentary remains as being human.

Few researchers have endeavored to approach the issue of bone histology in non-human specimens. In the forensic setting, the discovery of fragmentary remains poses the question of identity. Is it human or non-human? Determining the origin of such fragments is essential for defining an investigation, but if the remains do appear to be non-human, further analysis is not always of primary interest.

If the specimen does prove to be non-human, it is often useful and important to learn the identity of the animal species. Being able to successfully identify bone fragments by genus or species aids the physical anthropologist. A more clear understanding of what non-human species look like at the histological level would essentially strengthen the determination of identification.

The white-tailed deer (*Odocoileus virginianus*) is common to the Southeastern United States and in that region is sometimes found in forensic settings, commingled with or alongside of human remains. Developing a firm grasp of the histological character of the white-tailed deer is the first step of many in the establishment of a comprehensive method of using histology for the identification of osseous fragments.

To adequately assess *Odocoileus virginianus*, it is necessary to understand variation in histological character as a function of location on the diaphysis of a bone as well as differences between bones. The developmental stage of the deer may also have an affect on the appearance of any histological traits as bone remodels with increasing age.

To address these questions, this research focused on right long bones procured from five deer of varying ages: 0.75 years, 1.5 years, 2.5 years, 3 years, 4 years, and 6.5 years. The femur, humerus, radius, metacarpal, metatarsal, and tibia were separated out for thin-section preparation and histological analysis.

With the aid of a Buehler Isomet 1000 saw, two 0.08 mm sections were cut at three-centimeter intervals on each diaphysis of the bones. The bone samples were then mounted on slides using Permout solution and cover slips and left to dry. These thin-sections were examined under a Leica DMRX research light microscope at 100x magnification. The presence of all histological structures was described and noted for each slide. Digital images of the characteristic plexiform bone and primary canals were photographed using a Sony video uplink. When evidence of bone remodeling was recorded, area measurements were taken on secondary osteons and Haversian canals via Image Pro Express 4.0.

The observations and the collected measurement data from each femur and humerus of the deer samples were subjected to a repeated measures ANOVA to assess inter- and intra-bone variability among and between the deer. The statistical findings will provide a good basis to indicate if white-tailed deer can be positively identified by histological

analysis regardless of the loci of the bone fragment in question and regardless of age.

The statistical analysis results indicated no significant mean differences within shafts or across ages for osteon area in the femur or humerus. The results also indicated no significant mean differences within shafts or across ages for Haversian canal areas in the femur. A significance difference was noted between the Haversian canal areas in the nine-month deer and the 2.5-year-old deer humeri.

Based on the findings, a blind test was performed on five unidentified bones samples to discern deer from other ungulates based on osteon areas. The methodology and results of this research were successfully utilized to distinguish white-tailed deer bone from *Sus scrofa* (wild board), *Ovis Aries* (sheep), and *Capra hircus* (goat). The ability to do so speaks to the usefulness and reliability of bone histology in forensic anthropology and calls for more similar research endeavors in the future.

Histology, Fragmentary Remains, White-Tailed Deer

H2 Identification of the Rib Number by Metric Study in Korean

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After attending this presentation, attendees will understand that the importance and purpose of placing ribs in their proper anatomical order are to determine the number of individuals and for the application of techniques for establishing age-at-death using cartilaginous and osseous changes in the sternal end of the ribs.

This presentation will impact the forensic community and/or humanity by investigating a correct sequence of ribs and the usefulness of ribs as a distinction among populations.

Rib seriation has important applications in both bioarchaeology and forensic anthropology. The correct siding and sequencing of human ribs are an essential process in forensic anthropology and medico-legal investigation. The importance and purpose of placing ribs in their proper anatomical order are to determine the number of individuals represented, apply techniques for establishing age-at-death using cartilaginous and osseous changes in the sternal end of the ribs. The aim of this study is described a rib seriation correctly in Korean and compared with other populations.

The sample was the dry rib of 50 sets that known age and sex at Department of Anatomy, College of Medicine, Yonsei University. The method investigated was based on three metric variables: superior costo-transverse crest height (SCTCH), articular facet of the tubercle-to-angle length (AFTAL), and head-to-articular facet length (HAFL).

Analysis of variance showed that SCTCH, AFTAL, and HAFL were significantly associated (P less than 0.001) with rib number on both right and left sides. The variables SCTCH and HAFL were associated with the

central ribs (3rd through 6th) on both sides. SCTCH generally increased in size with rib number and variables AFTAL and JAFL showed a tendency to increase from ribs 2 – 7). The accuracy of discriminant analysis was 81.3% in SCTCH, 83.3% in AFTAL, and 85.4% in HAFL on both sides. THE variable AFTAL ($r^2=0.86$) is the useful dimension for rib seriation and SCTCH (84%) is useful for sexual dimorphism.

This result would distinguish between European Whites and Koreans using the rib.

Rib Seriation, Sex Determination, Korean

H3 Pedagogy of Practicing Forensic Anthropologists: A Collection of Our History

Joseph T. Hefner, MA, University of Tennessee, Department of Anthropology, 250 South Stadium Hall, Knoxville, TN 37996; Natalie M. Uhl, BS, University of Indianapolis, 1400 East Hanna Avenue, Indianapolis, IN 46227; Stanley Rhine, PhD, University of New Mexico, Department of Anthropology, MSC01-1040 Anthropology, Albuquerque, NM 87131-0001; and William M. Bass, PhD, University of Tennessee, Department of Anthropology, 250 South Stadium Hall, Knoxville, TN 37996*

After attending this presentation, attendees will have an historical view of the Physical Anthropology Section of the American Academy of Forensic Science as well as understand the need to facilitate the collection, preservation, and documentation of the pedagogical history of the section.

This presentation will impact the forensic community and/or humanity by demonstrating that the academic history of modern practitioners represents the foundation upon which the profession has grown. Collecting, preserving, and documenting this lineage is of great importance to the understanding of modern forensic anthropology.

The History Committee within the Physical Anthropology section of the American Academy of Forensic Science was established at the 2005 AAFS meetings in New Orleans, LA. The committee is chaired by Dr. John Williams and includes Dr. Douglas Ubelaker, Dr. Eugene Giles, Mr. Greg Berg, Ms. Anne Marie Mires, and Mr. Joe Hefner. Charged with the collection, preservation, and documentation of the history of the Physical Anthropology section, the committee is actively seeking to document all levels of activity, including the academic histories for Physical Anthropology section members.

The pedagogical nature of anthropology is a fundamental characteristic of the entire field. Historical figures like Earnest Hooton and Franz Boas are recognized for their contributions to a stable crop of students, many of whom are now recognized as some of the most influential members in the field. These very ‘students’ are now ogled at meetings, the victims of drive by “name tag sightings” and murmurs concerning a recent journal article or book. The academic lineage of forensic anthropology is essential for understanding current philosophies.

In a 1992 volume of *The Connective Tissue*, Dr. Stanley Rhine documented the academic lineages of nearly 130 MAs and PhDs within the field, gathering information on degree date, advisors, and location. Originally proposed by Dr. Madeline Hinkes, the information in Rhine’s list derived from the AAFS membership list, AAA guides, and informants, most notably Dr. Walter Birkby and Dr. Ted Rathbun. His dataset, which has acted as a catalyst for the current study, has unfortunately drifted into relative obscurity. Most of the recent PhD recipients recorded by Rhine in 1992 are now professors themselves, producing MAs and PhDs. Collecting up-to-date information will prevent any large gaps in the knowledge base of academic history.

In order to explore both traditional and nontraditional paths that have led current practitioners to the field, this poster seeks to document the academic lineage of the Physical Anthropology section of the American Academy of Forensic Science, by drawing on Dr. Rhine’s previous work

and by adding those individuals not included in the original compilation. Anthropologists are encouraged to provide information on their advisors, schools attended, and individual academic lineages. The purpose of this presentation is to explore these inter-relationships and provide the Section insight into its origins.

Preparatory analysis suggests the North American School of forensic anthropology can be traced almost entirely to the British School under the direct influence of Sir Author Keith. Keith is directly linked through historical figures such as Hooton, McCown, and others. The legacy of figures not traditionally associated with forensic anthropology provides insight into current methodologies and suggests the likely origins of some of the current practices. Academicians like Dr. William Bass and Dr. Alfred Hulse are noteworthy for their scientific contributions, but the large number of students that they produced is most significant for the current research. Likewise, researchers and non-academicians are noteworthy for their scientific contributions, but the student mentoring they have provided is also of great importance. The academic history of modern practitioners represents the foundation upon which the professional has grown. Collecting, preserving, and documenting this lineage is of great importance to the understanding of modern forensic anthropology.

Pedagogy, History, Physical Anthropology

H4 Forensic Anthropology in the Courtroom: Trends in Testimony

Elizabeth A. Murray, PhD, College of Mount St. Joseph, 5701 Delhi Road, Cincinnati, OH 45233-1670; and Bruce E. Anderson, PhD*, Forensic Science Center, 2825 East District Street, Tucson, AZ 85714*

After attending this presentation, attendees will learn about the frequency and nature of expert witness experiences among the membership of the Physical Anthropology section of the American Academy of Forensic Sciences.

This presentation will impact the forensic community and/or humanity by demonstrating the need for trends in testimony to be shared among the forensic anthropology membership and can be used to potentially direct areas of research in the future.

A certain amount of recent research by forensic anthropologists has apparently been induced or promoted by the Daubert decision. Numerous papers and presentations have focused on issues such as error rates and the replicability of previously published analytical methods. This research is certainly needed and the authors correctly stress the importance of the results of such research in terms of how forensic anthropology opinions should be rendered within the medico-legal resolution of a particular case. Partly because of this, the authors felt that it could be quite instructive to tabulate the types of issues in which forensic anthropologists are actually testifying. Results of such tabulation may prove useful in directing future research in forensic anthropology.

To obtain data related to this issue, the authors utilized the services of a commercial survey company to conduct an anonymous and IRB-approved on-line survey. The National Office of the American Academy of Forensic Sciences sent an electronic link to the survey to all ranks of membership in its Physical Anthropology Section. At the time of the writing of this abstract, 99 individuals had responded to the survey, representing a wide range of experience levels, from students to individuals who have been practicing for over 30 years. Survey questions asked respondents their current educational level, their primary employment setting, and the approximate percentage of their workload devoted to casework, research, and teaching in the field.

After being asked to provide basic career information, the survey queried whether or not the respondent had ever testified as an expert witness in the field of forensic anthropology (including courtroom and other forms of sworn testimony). At the time of the writing of this abstract, 56.6% of the survey respondents had testified, although most testified rarely. If they had testified, participants were asked to answer

further questions about courtroom experiences throughout their career. Questions about sworn testimony were related to the frequency of such experiences, as well as the typical nature of the expert opinions forensic anthropologists are asked to render. Respondents were asked how often their testimony involved chain of custody issues, providing a biological profile, positive identification, traumatic injuries and other pathologies, the postmortem interval, matters of recovery or scene investigation, and whether or not they had provided a second opinion relevant to the work of another anthropologist. To assess trends in the field, the survey asked anthropologists to break these experiences into those occurring in the past five years, and if the extent of their practice exceeded five years, how often and what types of testimony they typically provided earlier in their career.

Initial survey results regarding the past five years indicate that most forensic anthropologists do not frequently serve as expert witnesses. When forensic anthropologists have provided sworn testimony in the past five years, it is more often regarding trauma and pathology, recovery or scene investigation, or the postmortem interval. Forensic anthropologists are least asked to render opinions on chain of custody issues, positive identifications, and are very seldom asked to testify as second opinions relative to the work of other anthropologists. When compared to the expert witness experiences of anthropologists in the earlier years of their career (for those with more than five years of experience) the frequency of most types of testimony shows little change over time. However, survey data suggest increases in testimony with regard to recovery and scene investigation, and the postmortem interval. The poster presentation will provide a more robust examination of these data and a discussion on the final survey results.

Expert Witness Testimony, Forensic Anthropology, *Daubert* Decision

H5 Houston Mass Murder Victims: 33 Years Later

Sharon M. Derrick, PhD, Michele Hunt, BS, and Luis A. Sanchez, MD,
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After attending this presentation, attendees will learn about the difficulties inherent in forensic identification of skeletonized decedents in general through a description and evaluation of the standard steps that are taken in a medical examiner setting to identify these individuals. Further, because the identification of homicide victims from "cold cases" presents a different set of challenges, an example of the process as it applies to an older high-profile case will be provided and discussed.

The description and evaluation of methodological solutions used to identify skeletonized individuals recovered from a forensic context several decades in the past will impact the forensic community and/or humanity by providing information on the efficacy of these solutions to other researchers in the field. Successful resolution of older cases also offers justification for the presence of at least one full-time staff anthropologist and a designated identification unit at medical examiner facilities.

Viewers of this poster presentation will be shown the difficulties inherent in forensic identification of skeletonized decedents in general through a description and evaluation of the standard steps that are taken in a medical examiner setting to identify these individuals. Further, because the identification of homicide victims from "cold cases" presents a different set of challenges, an example of the process as it applies to an older high-profile case will be provided and discussed.

Skeletonized individuals recovered under forensic circumstances often remain unidentified for an extended period of time even in light of modern DNA analysis, new investigative methods, and artist facial reconstruction efforts. Cold cases that were investigated prior to the routine use of these methods may have resulted in the release of the decedent for burial as an unknown individual, or the remains may have been retained in a medical examiner facility awaiting a positive

identification. The presence of forensic anthropologists on staff in the medical examiner office setting and the formation of a designated identification unit provide the initiative, experience and person-hours to move forward on these difficult identifications. As a result of the development of such innovative programs, carefully conserved decedents from a mass murder case have received recent intensive study at the Harris County Medical Examiner's Office (HCME) in Houston, Texas.

The mention of Dean Corll, Elmer Wayne Henley, and David Brooks still elicit strong reactions from adult residents of Harris County and surrounding areas. It has been 33 years since the summer night that their murder spree was exposed, but the violent nature of the crimes still resounds, even in this age of graphic films and video games. Corll, also known on the street as "The Candy Man," died that night, but Henley and Brooks are both serving prison terms and continue to seek parole. The media interview Henley on a regular basis and this keeps the story fresh in the Houston community's consciousness.

On August 8, 1973, Henley called law enforcement after fatally shooting Dean Corll. Henley also advised officers that there were a number of bodies buried in a boathouse on the northwest side of Houston. According to documents from the time period, seventeen adolescent males in various stages of decomposition were discovered buried in the floor of the boathouse. Another nine adolescent males were subsequently recovered near Galveston and Lake Sam Rayburn, Texas, bringing the number of verified homicides in the investigation to 26. The 17 sets of remains recovered from the boathouse were brought to the HCME in Houston for postmortem examination. The nine sets of remains from the other two county jurisdictions were later transported to the HCME for additional examination. The majority of these decedents were identified and released. However, three of the recovered individuals and additional commingled remains (MNI = 4) were never identified and remain at the HCME.

The three discrete sets of unidentified remains were examined and a biological profile was developed by Dr. David Glassman, D-ABFA in 2004. Deoxyribonucleic Acid (DNA) was recovered from these individuals in 2006 and submitted to the HCME Forensic Laboratory for analysis. The additional commingled remains are currently being examined and profiled by HCME staff. The new information collected from these cases will be used to seek identification through reference samples obtained from living relatives and any corroborating evidence provided by friends or acquaintances. The objective of this renewed focus on the Houston Mass Murder cases is to provide an identity for these individuals and ultimately release them from the HCME facility.

Corll, Henley, Unidentified

H6 The Bone Histology of Bear Paws and Human Hands

Brannon I. Jones, MA, University of Tennessee, 250 South Stadium
Hall, Department of Anthropology, Knoxville, TN 37996*

After attending this presentation, attendees will learn about the potential histological differences in the metacarpals and phalanges of a human hand and a black bear (*Ursus americanus*) paw.

This presentation will impact the forensic community and/or humanity by aiding in the separation and identification of morphologically similar osseous human and nonhuman remains.

The similarities between the bones of human hands and bear paws have been noted by numerous authors, and the morphological similarities and differences have been described extensively. While useful when whole bones are discovered, gross morphological characteristics may fail in the context of damaged or fragmented bones. In these situations, an alternative method of identification is necessary. Histology has been used to describe both human and nonhuman bones, and can be employed in separating bones as similar as those in this study. The histology of bear

bones has been limited to femur and tibia midshaft cross sections, so descriptions of bear metacarpals and phalanges is needed in order to differentiate these from the same bones in humans.

The hands of a human male in his mid-thirties and the front paws of a two to three year old bear were obtained for this study. The right second ray of each was selected for study in order to remain consistent with previous research focusing on the second metacarpal of humans. Each ray consisted of the metacarpal, proximal phalanx, and middle phalanx, the distal phalanx was used only in the human. Thin sections were made using Buehler isomet low speed saw at midshaft of all bones, and thin sections were also made at the proximal and distal ends of the metacarpals and proximal phalanges. All thin sections were cut 12 μm thick and ground using a Metaserv 2000 grinder/polisher. Slides were viewed using a LEICA DMRX light microscope and photographed using the computer program ImagePro Express.

Several quantitative and qualitative features were examined in order to determine the difference between human and bear bones at the histological level. Quantitative measurements included maximum osteon diameter (μm), osteon area (μm^2), maximum Haversian canal diameter (μm), and Haversian canal area (μm^2). One to four osteons were measured per thin section and the values averaged for each species. The means were then tested using ANOVA to see if they differed between human and bear. All four variables gave p-values less than 0.05, meaning humans and bears were statistically different in all four measurements. In addition, osteon density and lacunae density were calculated for both species, and both of these variables appear to differ by species, with bear bone having more osteons and lacunae per area examined.

The qualitative features that were analyzed included osteon banding, resorption spaces, and plexiform bone. Osteon banding appeared only in the bear thin sections, specifically in the second metacarpal, and never in the human thin sections. Resorption spaces which appeared in rows were also indicative of this osteon banding and were seen in a few of the bear thin sections and never in the human thin sections. Plexiform bone, which is usually a nonhuman trait, was also seen in a few of the bear thin sections and never in the human thin sections. While preliminary, this study indicates that it is possible to differentiate between bear and human metacarpals and phalanges using a combination of qualitative and quantitative microscopic features.

Bone Histology, Nonhuman Remains, Black Bear

H7 Exhumation of an Historical Gravesite at Taos Cemetery

Mary H. Dudley, MD, Sedgwick County Regional Forensic Science Center, 1109 North Minneapolis, Wichita, KS 67214; Joy Veters, BS, Wichita State University - Department of Anthropology, 1845 Fairmount, Wichita, KS 67260; and Angela E. Benefiel, BA, Sedgwick County Regional Forensic Science Center, 1109 North Minneapolis, Wichita, KS 67214*

The goal of this presentation is to identify the process of recovery and describe physical findings from skeletonized remains.

This presentation will impact the forensic community and/or humanity by identifying the process of recovering skeletal remains, agencies to notify and information which may be obtained from skeletal remains.

While preparing a grave in the Kit Carson family cemetery plot in Taos, New Mexico, workers uncovered the remains of an unknown individual. Cemetery records did not show a previous burial at that site. The remains were disinterred and transported to the Office of the Medical Investigator (OMI) in Albuquerque, New Mexico for examination and determination of their medical-legal significance. This poster presentation details who to contact if remains are found, the process of exhuming remains, and the evaluation of the remains conducted by individuals from

OMI and the Laboratories of Physical Anthropology, Maxwell Museum of Anthropology, University of New Mexico.

When human remains are discovered, there are several agencies to notify. It is important to establish if the remains are of forensic or historical significance. In New Mexico, agencies to notify include the local police department, Office of the Medical Investigator, and the Historical Preservation Division, the Anthropology department, the Forest Service, cemetery records office, city archives, and the Office of Indian Affairs. When exhuming remains forensic anthropologists and most law enforcement personnel are aware that careful collection of everything (bones, teeth, hair, clothing, valuables, and samples of the casket and nails) and to utilize the correct tools, such as a camera, gloves, brush, sieve, trowel, and a shovel to record the grave site and preserve the remains without damaging them on recovery.

The remains were determined to be historic in nature and thought to represent a 5'5" Hispanic male who was in his mid-30s at the time of death. After evaluating the remains, several interesting anomalies and evidence of trauma were identified. This individual showed little osteoarthritic development in the lumbar vertebrae. The superior surface of the sacrum and the fifth, fourth, and second lumbar vertebra were seen to have slight lipping. On the right scapula, there was an isolated rounded osteophyte on the inferior margin of the posterior portion of the glenoid fossa. These observations were considered appropriate for the degree of arthritic change for the age of mid-30's. The thyroid and cricoid cartilages were ossified.

Prior to death, this individual had five teeth missing. There was an abscess formation in the upper jaw above the left lateral incisor suggesting possible tooth decay. On the sternum, there were two fusion anomalies that produced foramina including a 7x10mm defect centered in the fourth element of the corpus of the sternum and a second defect in the xiphoid process, which was fused to the corpus. The sternum foramen may be mistaken for a gunshot wound defect to the untrained observer.

This individual showed several interesting areas of antemortem trauma. The right nasal bone had been mildly fractured and healed without distortion. There were also fractures in the 7th and 10th left ribs. Fractures to the proximal left humerus and proximal left radius demonstrate a significant amount of damage, drastically altered appearance, and irregular bone formation. Radiographs revealed radiopaque particles at both fracture sites which are characteristic of lead fragments resulting from a gunshot wound. A persistent infection set in and a bony involucrum formed, which resulted in osteomyelitis and periostitis, most likely resulting in a draining fistula.

This exhumation stirred interest in the Taos area and a newspaper article described the findings of the UNM Anthropology Department and showed a clay facial reconstruction for view, in case someone recognized him as a distant relative from old photos. His remains were returned to the Taos area.

Forensic Anthropology, Antemortem Trauma, Exhumation

H8 The Relationship Between Bone Weight and Age at Death

Emily J. Loucks, BA, University of Tennessee, 250 South Stadium Hall, Department of Anthropology, Knoxville, TN 37996; and Brannon I. Jones, MA, University of Tennessee, 250 South Stadium Hall, Department of Anthropology, Knoxville, TN 37996*

The goal of this presentation is to determine the relationship between bone weight and age at death in skeletons from the William M. Bass Donated Collection.

This presentation will impact the forensic community and/or humanity by aiding in the age estimation of unidentified remains and the separation of commingled remains.

Bone weight has been studied intermittently with various approaches and goals. Previous studies have utilized skeletons with various taphonomic histories and bone conditions. Researchers have used bones from anatomical collections, fresh cadavers, and naturally skeletonized individuals. Due to differences in histories, the conditions of the bones have varied from dry but still greasy, dry and mechanically degreased, and dry and naturally degreased. These studies have compared relationships between individual bones within a single skeleton, whole skeletal weight and age, individual bone weight and age, and the effects of disease. In addition, the differences in ancestral groups, male and female individuals, left and right sided bones, and weight bearing versus non-weight bearing bones have been studied.

The sample employed in this study is approximately 400 white males and females 20 to 100 years of age from the William M. Bass Donated Collection at the University of Tennessee. Note was made of obese individuals and those with chronic illnesses and disease. Each of the skeletons shares a common taphonomic history, including decomposition at the Anthropological Research Facility and processing. Most of the individuals decomposed on the ground surface of a wooded environment; however, several individuals decomposed in shallow burials. Processing included removal of soft tissue and simmering in hot water.

For each of the skeletons, the following bones were weighed in grams with a digital scale: clavicle, scapula, humerus, radius, ulna, os coxae, sacrum, femur, tibia, and fibula. The left and right were both measured for all paired bones. Individual bones exhibiting pathology or orthopedic devices that may affect weight were excluded. Measurements of each bone were used to control for size. For example, in the humerus, the maximum length, epicondylar breadth, and maximum diameter of the head were used.

The relationship between bone weight and age at death was analyzed by performing regression analysis and producing correlation coefficients for several variables. A test for independence was executed for each bone in order to determine that bone weight was not dependent on size. Once independence was determined, the relationship between age and weight for each bone was analyzed in four separate groups: male left, male right, female left and female right. In addition, the relationship between age and each entire limb was examined. Preliminary results show that for the humerus, weight and size are independent of one another. A significant inverse relationship was found between age and weight for both males and females, although the relationship was stronger for females. Males and females both showed a higher correlation between age and weight in the left humerus than the right humerus, which may be related to handedness. Similar results are expected for the other arm bones; however, the weight bearing bones of the pelvis and lower limbs may not show such a strong correlation.

While this study is preliminary and not capable of aging an individual from bone weight, it is hoped that further research will allow weight to be used in combination with other techniques to estimate age at death. With the complexity and confusion of some current aging techniques, the prospect of simply weighing a bone or combination of bones and narrowing in on an age at death makes this and future research worthwhile.

Bone Weight, Human Variation, Age at Death

H9 Paleopathological Diagnosis of Leprosy in Skeletons From a French Medieval Leper

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After attending this presentation, attendees will understand that the paleopathology of leprosy can be very useful in the understanding the past history of the disease and use this understanding to predict its course in the future. The study of skeletons may enrich the relatively poor osteological documentation of leprosy in Middle Age in Europe.

This presentation will impact the forensic community and/or humanity by discussing the excavation of a sample of human skeletons from a medieval leper site that has provided the largest sample from this period in France. The findings that 45% of the skeletons buried in the Saint-Lazarus chapel of Tours suffered from leprosy will provide a unique opportunity to interpret historical sources, medical documents, and osteoarcheological data regarding medieval leprosy.

Introduction: Leprosy is a chronic granulomatous infectious disease caused by *Mycobacterium leprae*. According to documentary sources, leprosy was a relatively common occurrence in later Medieval Europe. It seems to have culminated in the 13th and 14th centuries when around one quarter of the adult population died with signs of leprosy. However, the number of cases diagnosed in archaeologically derived skeletal material from all areas of Europe is low. When leprosy affects the skeleton, a number of specific and non-specific bony changes occur during the pathogenesis. In the present study, all the bone lesions in the skeletons from 57 tombs of the necropolis of the Saint-Lazarus chapel (Tours, France) in relation to a diagnosis of leprosy are described and discussed.

Material and Methods: The Saint-Lazarus chapel appears to have been in use from the 12th to the 17th centuries and was known to have been a medieval leper colony. The excavated skeletons were found during a building construction in 1993. In total, 57 burials were identified. The 57th burial was in fact identified as scattered remains from disturbed burials. Sex and age for all burials were determined according to current anthropological methods. All the bone lesions were noted by two different observers. Pathognomonic skeletal changes of low resistance (lepromatous) leprosy included erosive changes of the anterior nasal spine, resorption of the alveolar ridge with frequent loss of incisor teeth and palatal perforations (*facies leprosa*). A variety of secondary skeletal changes may develop due to peripheral neural involvement by the infectious process. The most characteristic of these are trophic reabsorptive changes in the terminal phalanges of the feet and hands. The phalanges frequently are the site of other absorptive changes which lead to "shark-tooth" deformities. Periostitis of the tibiae and fibulae may be the consequence of ascending secondary infections or of periosteal involvement by the primary infection.

Results: 39.3% of the skeletons were males, 21.4% were females, 14.3% were adolescents. Sex determination was not possible for 25% of the individuals. Rhinomaxillary changes were noted for 45% of the available skulls: among them there were seven cases of nasal spine atrophy, six irregular perforations of the superior surface of the hard palate and 2 central atrophy of the maxillary alveolar process two skeletons presented acro-osteolysis of the 5th metatarsal. Periostitis of the tibiae and fibulae was found on five skeletons. Enthesophytes and osteolytic lesions were noted at the insertion sites of several ligaments. Cribriform orbitalia was found on two individuals.

Discussion: Only 45% of individuals known to live in a medieval leper colony had pathognomonic lesions of the disease, although leprosy sufferers were banished and removed from society. There may be many reasons for this. First if people contract the high resistant (tuberculoid) form of the infection they may not develop any bone changes. Second, people with leprosy may have died before there was time for bone change to occur. In both these scenarios, the evidence would be absent skeletally. Thirdly, leprosy may have been misdiagnosed: people with another disease may have been labeled as leprous. A number of other diseases that may produce the same skeletal lesions are discussed.

Paleopathology, Leprosy, Facies Leprosa

H10 Bone Fragmentation Created by a Mechanical Wood Chipper

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After attending this presentation, attendees will learn that dismemberment using a mechanical wood chipper quickly reduces bone to small fragments as well as the fact that despite fragmentation it is possible to segregate bone based on the type of woodchipper used.

This presentation will impact the forensic community and/or humanity by demonstrating the possibility of identifying the class of machine used to mechanically fragment bone.

A recent motion picture highlighted the use of a mechanical woodchipper in the disposal of human remains. Although body dismemberment using this means appears efficient, documented cases are rare. To determine the effect of a mechanical woodchipper on bone, a sample of 10 long bones of White Tailed Deer (*Odocoileus virginianus*) were processed through a commercially available 6.5 hp woodchipper/shredder. Modern wood chippers utilize two different rotating blades or hammers in reducing the size of vegetative matter. The chipper uses several short blades directly attached to a flywheel powered by a gasoline motor. The shredder component uses a single blade similar to that of a lawnmower attached to the motor shaft. For the particular unit used in this procedure, material processed by either the chipper or shredder is forced out a single opening using spring loaded flails mounted to a flywheel.

Five bones were processed through the chipper component and five were processed through the shredder component. After processing the bones were cleaned and dried. The dried bone fragments were weighed to the nearest gram. Mechanical sieves segregated the fragments by size. Three categories were created: larger than a size 5 sieve, between a size 5 and size 10 sieve, and smaller than a size 10 sieve. The segregated fragments were weighed and the percentage of the total dry weight was calculated. The mean weights for each category were compared by processing type. A t-test was significant at the .001 or higher that the means were significantly different for chipper vs. shredder.

The largest fragments (greater than a size 5 sieve) were further segregated into two subcategories, those with attached cancellous bone and those without attached cancellous bone. The percentage weight of cancellous attached bone fragments of the total fragment weight was calculated. Chipped bone and shredded bone displayed the lowest and highest weight percentage of cancellous attached bone at 28% and 73% respectively. A t-test was not significant that the means for cancellous attached fragments were different for chipper vs. shredder.

Comparing the two processing types found that the chipper reduced the bone to smaller, more uniform fragments (average of 39.8% vs. 73.4% of total weight greater than a size 5 sieve). Some shredded fragments exceeded 38 mm in length and were identifiable as to bone type (i.e., humerus). The size of these fragments was such that further analysis was still possible. Chipped fragments rarely exceed 12 mm in length.

The most useful criteria in determining what form of wood chipper/shredder was used are: 1) fragment size segregation, 2) identifiable fragments as to bone type. Both methods are predicated on complete or near complete recovery of fragments. Any loss of fragments will alter the prediction of wood chipper type.

Bone Trauma, Woodchipper, Dismemberment

H11 Microscopic Characteristics of Hacking Trauma on Bone: The Potential for Interpretation and Identification

Ariana P. Ridgely, BA, Department of Anthropology, New York University, 25 Waverly Place, New York, NY 10003*

After attending this presentation, attendees will gain a better understanding of the utility of microscopic characteristics of hacking trauma in correct weapon identification as well as the results of qualitative analysis of microscopic (and macroscopic) characteristics of cut marks inflicted by hacking trauma, using various common sharp instruments, as observed in Stereo zoom and 3D incident light microscope images of striations present on kerf walls.

This presentation will impact the forensic community and/or humanity by addressing the utility of microscopic characteristics of hacking trauma in weapon identification, their potential in creating reliable sets of class characteristics in future tool mark analysis, and the usefulness of different kinds of light microscopy in interpretation of cut marks.

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This presentation will impact the forensic community and/or humanity by addressing the utility of microscopic characteristics of hacking trauma in weapon identification, their potential in creating reliable sets of class characteristics in future tool mark analysis, and the usefulness of different kinds of light microscopy in interpretation of cut marks.

While the field of tool mark analysis continues to grow and while much attention has been given to characteristics of saw and slice marks on bone, little research has been conducted in order to determine if similar patterns and class characteristics can be extracted from cut marks caused by hacking trauma. The few studies that have been published focused only on the microscopic characteristics of specific sharp instruments, namely cleavers, axes, and machetes. In addition, these studies have all employed scanning electron microscopy to gain images of striations on cut mark kerf walls. While SEM is becoming a more and more popular method for viewing tool marks, it has several disadvantages for practical use including: time intensive preparation of samples, sample size necessary, and high cost. In addition, it must be recognized that not all institutions have access to SEM and it should be determined if there is an alternative imaging system that can adequately capture these images. Light microscopy has several practical advantages. Images can be taken from simple casts without altering the cast or specimen and light microscopes are less complicated to use and are more common.

In the current study, various types and sizes of knives (plus a machete and axe) were used to create hack marks in large sections of femora previously cut and cleaned for other research. Each tool was assigned one femur consisting of a fragment cut from approximately mid-shaft and a longer section including distal shaft, metaphysis, and epiphysis. Multiple cut marks (hack marks) were made using each tool and were then casted using low viscosity injection-type impression material. Casts were

viewed under both stereo zoom (Leica MZ-APO) and real-time 3D incident light (Edge Scientific H160) microscopes. Images captured were then analyzed for striation patterns and the ability to match images of specific cut marks to each other and to their respective weapon. In addition, images and patterns were compared to determine if larger tool-type characteristics could be determined.

While striation patterns were successfully captured and these images could generally be associated with cut marks from the same bone (and therefore, weapon) and respectively to the tool used, overall tool class characteristics were much more difficult to define and may prove unreliable. Light microscopy was adequate in visualizing striation patterns on kerf walls. However, more research comparing the images captured to some taken using SEM must be done to show whether one method is better than the other for studying hacking trauma characteristics.

These results show that although kerf striations on cut marks caused by hacking trauma can potentially be used for identification of specific weapons used, more research is required in order to create reliable class characteristics that could be used to determine tool-type when no suspected weapon is available.

Forensic Anthropology, Cut Mark Analysis, Microscopy

H12 Inter-Tidal Decomposition Patterns in Croatia: An Experiment using *Sus scrofa* Pedal Elements

Branka Franicevic, MSc, University of Bradford, Department of Archaeological Sciences, Bradford, BD7 1DP, United Kingdom; and Robert F. Pastor, PhD, University of Bradford, Biological Anthropology Research Centre, Department of Archaeological Sciences, Bradford, BD7 1DP, United Kingdom*

The goal of this presentation is to introduce participants to key aspects of decomposition patterns for individual body parts in a Mediterranean coastal environment during late autumn. It will address aspects of decay uncharacteristic for the decomposition of a whole corpse, and the main components of the process essential for the application to the post-mortem interval (PMI) determination. Photographic and descriptive data will be presented of the unique decomposition patterns of individual body parts from pig carrion in two inter-tidal zones of the Adriatic coast, Croatia. Aquatic insect activity, identified for the first time for this geographic region will also be discussed.

This presentation will impact the forensic community and/or humanity by demonstrating the identification of environmental and other factors that serve as a basis of decomposition patterns of different body parts. Application of the decomposition models presented in this study may aid in producing a more accurate estimation of PMI for dismembered and disarticulated human limbs.

This presentation will introduce participants to key aspects of decomposition patterns for individual body parts in a Mediterranean coastal environment during late autumn. It will address aspects of decay uncharacteristic for the decomposition of a whole corpse, and the main components of the process essential for the application to the post-mortem interval (PMI) determination. Photographic and descriptive data will be presented of the unique decomposition patterns of individual body parts from pig carrion in two inter-tidal zones of the Adriatic coast, Croatia. Aquatic insect activity, identified for the first time for this geographic region will also be discussed.

This poster will demonstrate that various PMI techniques used for a whole corpse and skeletonized remains in medico-legal investigations may overlook the potentially different biological and taphonomic

decomposition processes of individual body parts. The impact of these findings on forensic sciences and/or humanity includes the identification of environmental and other factors that serve as a basis of decomposition patterns of different body parts. Application of the decomposition models presented in this study may aid in producing a more accurate estimation of PMI for dismembered and disarticulated human limbs.

In a temperate central European coastal environment, soft-tissue decomposition could depend on the microclimate typical of marine or riverine ecosystems. In shallow waters for instance, typical factors that could cause soft tissue modification are of both terrestrial and aquatic nature, such as air temperature, exposure to the sunlight, or tidal fluctuation.

However, because putrefaction is almost certainly bacterially driven, it is hypothesized that with certain isolated single remains, absence of gastrointestinal organs result in the potentially different bacterial action affecting decomposition.

This experimental study was conducted in two inter-tidal zones, marine and riverine. The distance between the two depositories was approximately 70 metres to simulate isolated resources for small vertebrates and invertebrates in two different coastal sub zones in close proximity. Wire meshes were placed on the riverbank and on the shore platform, and exposed to sunlight throughout the day. Samples were in the middle tide zone and were submerged approximately every six hours. The sample size represented limb bones of a minimum of 20 *Sus scrofa* (ulnae, radii, carpals, metacarpals, tibiae, fibulae, tarsals, and metatarsals). Ten limbs in random order were used per depository. Observations of decomposition changes and the environmental data such as sea surface and air temperature were recorded daily. Microorganism extraction and pH sediment measurements were conducted twice a week. Fieldwork was carried out for the duration of 31 days, during the period from 28 October to 27 November 2005.

A total of five stages of decomposition were observed during a one-month period: Fresh, Putrefaction, Early Disintegration, Advanced Disintegration, and Decay. Contrary to previous research in this environment, all stages were purely terrestrial in nature, omitting bloating, floating, and submersion. The study demonstrated the process of decomposition of isolated single remains in this habitat to be more complex than occurs in the body as a whole, with an indication of a slower decomposition in comparison to whole carcasses, possibly due to the limited bacterial action involved. The effect of relative humidity and exposure to sunlight on rates of decomposition was significant. Spearman's rank correlation coefficient for humidity was: $r=+0.90$, $p=0.08$ for marine, and $r=+0.94$, $p=0.01$ for riverine sample. Exposure to sunlight yielded $r=+0.92$, $p=0.07$ for the marine sample and $r=+0.90$, $p=0.03$ for riverine sample. Interestingly, salinity was only marginally significant and for the riverine sample only ($r=-0.76$, $p=0.13$), with the variable correlation of -0.76 to 0.94 . None of the other environmental variables correlated significantly with the rates of decay.

Variability in decomposition patterns between marine and riverine microenvironments also yielded significant results for the number of days spent in each stage (Mann-Whitney test $U=338$, $n=2$, $p=0.032$), indicating a different pattern of decomposition between two sites (stated with 95% confidence). This is reflected in different rates of decay, biomass removal, and insect and scavenger succession.

Postmortem events in nature regularly include scavenger succession and limb dispersions, natural disarticulation or dismemberment as part of clandestine disposals. For these reasons, principles of decomposition patterns of isolated single remains for the purpose of PMI are recommended across the board to medico-legal investigators in dealing with single body remains in coastal environments with a similar climate to Croatia.

Postmortem Interval, Body Parts, Croatian Coast

H13 The Difference Between an Individual's Self-Reported, Perceived, and Actual Height and Its Forensic Significance

Valerie B. Russell, BA, 8 Thomas Court, Valley Cottage, NY 10989*

After attending this presentation, attendees will understand patterns of reporting error in self-reported height, discrepancies between the ways that others perceive an individual's height, and factors that may influence these discrepancies such as diurnal variation in a person's height and how these differences may affect the positive identification of an unknown, deceased individual.

This presentation will impact the forensic community and/or humanity by providing insight into the variability between an individual's estimated stature when it is reported via different means. Using the different methods discussed in this approach may furnish investigators with a very large range for an individual's stature which could preclude a positive identification from being made.

The role of the anthropologist in death investigations has ranged from the recovery to the analysis of human remains from single cases of homicide to mass fatality incidents in all corners of the world. In many cases, the forensic anthropologist is given the task of comparing antemortem (AM) records with postmortem (PM) information. The most common characteristics usually compared include basic attributes of the biological profile of the deceased, such as age, sex, and stature. The usefulness of these attributes for identification purposes relies on the existence of AM records for comparison purposes. It has long been noted that records do not accurately reflect an individual's height because of the difference between self-reported and actual measured height (Schlichting *et al.*, 1981; Himes and Roche, 1982; Palta *et al.*, 1982; Stewart, 1982; Boldsen *et al.*, 1986; Giles and Hutchinson, 1991; Willey and Falsetti, 1991). Furthermore, how biased is an estimation of that individual's stature by others, taking into account the demographics of that population?

The sample consists of Caucasian volunteers between the ages of 18 and 45 (n=63). A wall-mounted stadiometer was calibrated and stature was measured to the nearest one-tenth of a centimeter. Volunteers arrived in groups of five and were asked to silently estimate their own height and the height of the other volunteers in the group, recording these values in the corresponding spaces on their data collection sheets. After the data sheets were collected, their standing height was measured three times per volunteer. Volunteers returned between five and eight hours later and were measured three more times. Diurnal variation, the differences between self-reported, perceived and actual height, and the range of perceived heights were calculated.

The researcher's objectives are to discover if there are any patterns and/or relationships between sex and self-reported height, how an individual's height is perceived, and the variability of actual height at both times it was measured during the day. Also, determining if an individual's height has any affect on the accuracy of how they perceive another's height will be useful when family members and friends are called upon to provide information about an individual, which frequently happens in contexts outside the developed world, when documents of the deceased are nonexistent more often than not.

When a positive identification for a deceased individual is sought, AM medical records may be one of the primary sources for providing information. Measured stature may be available from this source, although information may not be up-to-date. If medical records are not available, other forms of identification, such as a driver's license, may be used for comparison, which would supply investigators with a self-reported stature estimation. In some cases, family and friends will be asked to provide information about the deceased, although they may have different perceptions of an individual's stature. These three sources of information may generate a very large range for an individual's purported stature, which could preclude a positive identification.

Unidentified, Stature, Self-Reported

H14 Sex and Stature Estimation Based on the Calcaneus, Talus, and Metatarsal Length

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After attending this presentation, attendees will understand an alternative method to sex determination and stature estimation based on the bones of the feet.

This presentation will impact the forensic community and/or humanity by demonstrating a means to aid in identification when remains are in a poorly preserved state allowing the investigator to determine sex and estimate stature based on the resilient bones of the feet.

It has long been known that a relationship exists between lower long limb bone lengths and stature; this is often used to estimate stature. However, on occasion an individual is only represented by fragments of the long bones, or the smaller, more compact bones of the feet. Although a relationship exists between the maximum length of these bones and an individual's height, very little research documents the utility of estimating stature from foot bones.

The purpose of this study was to provide investigators with stature regression formulae for use on the bones of the feet. Using the maximum length measurement of the right and left calcaneus, talus, and all ten metatarsals of 200 individuals (50 each of White females, White males, Black females, and Black males) from the Terry Collection, discriminate analyses were performed to confirm significant differences existed between the groups used in this study. Regression analyses followed which produced formulae to estimate stature based on race and sex for use when intact lower limb bones are not present.

Results from this study indicate that the foot bones are poor in their predictability of sex, race, and stature. However, when other methods of sex and stature estimation are unavailable, the bones of the feet provide a possible alternative method. In this study, more accurate sex determination was achieved based on the measurements for blacks than whites. Stature regression formulae from the foot bones of black females were found to be at least as accurate as those for metacarpals and fragmentary limb bones; foot bones from the other groups were not as accurate.

Ultimately, the aim of this study was to aid in the identification of servicemen from the Vietnam and Korean Wars who are recovered from archaeological contexts with poor skeletal representation or preservation. The robust and compact nature of the foot bones used in this study allows them to be recovered, especially in a burial or interment context. Therefore, this investigation was completed on these bones in order to offer investigators an alternative method of stature estimation when the use of other methods is not possible.

Stature, Metatarsals, Calcaneus

H15 Sex Determination of Koreans Through Cervical Vertebrae

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After attending this presentation, attendees will understand the preliminary results of biological profiles of Koreans from the documented skeletal collection at Yonsei University in Korea.

This presentation will impact the forensic community and/or humanity by demonstrating the results of a metric study about the cervical vertebrae that shows sexual dimorphism and the usefulness of the documented skeletal collection at Yonsei University for determination of biological profiles in Koreans.

Terry collection specimens housed at the Smithsonian Institution and Hamann-Todd collection individuals at the Cleveland Museum of Natural History are two well-known examples of documented human skeletal specimens. Many statistical studies of morphological characteristics about documented human skeletal specimens have been performed and provide information about the characteristics of a population. On the basis of these results, reconstruction of biological profile for unidentified skeletal remains can be possible. However, the statistical data about Korean ancestry has not been established because documented human skeletal specimens are lacking in Korea. The Department of Anatomy at Yonsei University College of Medicine has been collecting the skeletons from dissecting cadavers after anatomy class since the 1990s, and approximately 100 specimens were collected. This study will demonstrate the preliminary results on the determination of sex by metric study of the cervical vertebrae derived from studying this documented collection.

This study attempted to duplicate a series of metric dimensions as defined by previous studies; however, the sample size in the dissecting cadavers was limited. The list of measurements taken includes the dimensions of the vertebral body, dimensions of vertebral foramen (spinal canal), and the size of the vertebrae. Twenty-one measurements of the atlas [length and width of atlas, maximum length and width of superior and inferior articular facets, maximum breadth between superior and inferior articular facets, sagittal and transverse diameter of vertebral foramen (spinal canal)] and 14 measurements of the axis were taken. All measurements were taken using digimatic caliper (Mitutoyo Co., Japan) and statistical analyses were performed using SPSS (version 11.0).

Among the 21 measurements of the atlas, the maximum breadth between the superior articular facets exhibited the strongest principal component for determination of sex. Atlas width also exhibited strong relation with sex, while maximum lengths and widths of superior & inferior articular facet did not. The latter measurements were reported to suggest sexual dimorphism in previous studies, and this fact might cause difficulty in determination of sex for fragmentary atlas in Koreans. However, six measurements were selected in arbitrary discriminant functions, and showed more than 85% of hit ratio. Concerning the 14 measurements of the axis, axis width exhibited the strongest principal component for determination of sex, and discriminant functions showed more than 80% of hit ratio. The sagittal and transverse diameter of the

vertebral foramen (spinal canal) of the axis appeared to exhibit a relationship with sex, but those of the atlas did not.

This presentation could indicate that metric data of cervical vertebrae are helpful to determine the sex in Koreans especially certain measurements of the atlas and axis. Also the documented skeletal collection at Yonsei University could be helpful to establish the Korean biological profile. Further investigation is necessary so that differences among ancestries could be performed, and common landmarks for measurements of sex-determination using cervical vertebrae would be established.

Koreans, Sex-determination, Cervical Vertebrae

H16 Stages of Epiphyseal Union in the Cervical Vertebrae of Young Adult Skeletons

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After attending this presentation, attendees will have an understanding of the stages of epiphyseal union of the cervical vertebral centra and its utility in aging an individual through observational analysis.

This presentation will impact the forensic community and/or humanity by contributing to the overall body of knowledge of forensic anthropology and skeletal analysis. Age estimation is one of the greatest challenges faced by forensic anthropologists and this presentation expands the knowledge of the maturation of the cervical vertebrae and its utility for age estimation for young adult skeletons.

The goal of this presentation is to introduce the application of the Albert and Maples (1995) stages of epiphyseal union to the cervical vertebrae and the utility of doing so. These findings contribute to the overall body of knowledge of skeletal analyses, specifically focused on the understanding of the timing and rate of epiphyseal union in the cervical vertebrae, as well as the rest of the vertebral column.

For this study, 77 individuals from the Hamann-Todd Osteological Collection housed at the Cleveland Museum of Natural History were observed. The sample consisted of 11 white females, 27 black females, 15 white males, and 24 black males aged 12 to 27 years at death. Eleven surfaces of the cervical vertebral centra were scored based on the method developed by Albert and Maples (1995). The eleven surfaces include the inferior surface of C2 and the superior and inferior surfaces of C3 through C7. Each surface received a score between 0 and 3 to represent the stage of epiphyseal union. Stage 0 represents no union, stage 1 represents beginning union with minimal attachment between the epiphyses and centra, stage 2 is characterized by almost complete union, and stage 3 is characterized by a completely mature vertebral body.

A review of the literature displays past discussions on the sequence of epiphyseal union throughout the body by Stevenson (1924) and Todd (1930), and radiographic analyses of epiphyseal union by several authors including Flecker (1942) and Girdany and Golden (1952). A radiographic analysis of epiphyseal union can only demonstrate incomplete or complete epiphyses, whereas an anthroposcopic analysis enables the researcher to observe the progression of union of the epiphyses, and therefore, facilitates the development of a scoring method. Observations about the extent to which the union has progressed are important in understanding the amount of time it takes for complete fusion to occur and any pattern in how the fusion occurs.

The timing and rate of epiphyseal union for the cervical vertebrae was studied to determine its relationship to the known age of the decedents in the sample. Results from cervical vertebral centra were compared to results of thoracic and first two lumbar vertebrae from the previous Albert and Maples (1995) study to determine if the rate and pattern of epiphyses of the centra were similar or different.

Observational and statistical analyses of the rate and pattern of the progress of epiphyseal union of the vertebral centra were performed.

Observations did not result in significant findings regarding the pattern of epiphyseal union for the vertebral centra. However, in regards to comparison throughout the entire vertebral column, the vertebral centra epiphyseal union of the cervical vertebrae initiated union as early as 12 years whereas the youngest individual to exhibit beginning union on any vertebrae was 14 years in females and 16 years, 4 months in males in the Albert and Maples (1995) sample of thoracic and first two lumbar vertebrae. Statistical analyses resulted in the same correlation between age and stage of epiphyseal union as that found by Albert and Maples (1995) showing the reliability of the scoring method throughout the entire vertebral column. This study demonstrated that aging an individual through observations of cervical vertebral centra epiphyseal union is as accurate and reliable as using the thoracic and first two lumbar vertebrae.

The results of this research provide additional information about cervical vertebral centra epiphyseal union including the time at which beginning union initiates, the progress of union, and the age of complete union. This information aids in an age analyses for a biological profile of an unknown individual. This research could potentially help in both archaeological and forensic situations, such as in mass disaster or mass grave circumstances, concerning commingled remains.

Cervical Vertebrae, Age, Epiphyseal Union

H17 New Method of Skeletal Age Estimation Based on Progressive Morphological Changes in Vertebral Column

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After attending this presentation, attendees will be introduced to a new method of age estimation based on changes in the morphology in thoracic and lumbar vertebrae.

This presentation will impact the forensic community and/or humanity by allowing forensic anthropologists to verify and use this new aging method for narrowing age ranges estimation, and therefore for more correct age at death estimation, essential in identification of unknown human remains.

The estimation of age at death from the skeletal remains of unknown individuals is an essential part of the identification process (Krogman and Iscan, 1986). During the last decades many anthropologists have tried to modify old aging methods as well as develop new ones in order to achieve greater accuracy in estimation of age at death of unknown skeletal remains. Most of these efforts were concerned either with improving and testing the effectiveness of accepted standards or with introducing new aging methods based on age-related changes in such bones as the sternal rib (Iscan et al., 1984) and the auricular surface of ilium (Lovejoy et al., 1985). These latter sites were chosen because previous observations indicated that changes occurred in these skeletal elements throughout an individual's life.

Although reported figures differ, about 30,000 people were unaccounted for and considered "missing" after three and a half years of war in Bosnia and Herzegovina (1992-1995). The exhumation and identification process began immediately following the end of the war. During the examination of hundreds of skeletal remains exhumed in Bosnia and Herzegovina, the authors found that the pattern of changes observed in the vertebral body can be used as additional indicators for estimation of age at death. The variables that contribute to the overall pattern of change include (1) the sequence of fusion of the internal rim of the epiphyseal rings to the surface of the vertebral body, (2) the subsequent absorption of the rings into body, and (3) age related changes to superior and inferior edges and surfaces of the body itself.

The progression of the union of epiphyseal rings in thoracic and lumbar vertebrae in teenagers and young adults was studied and described

by McKern and Stewart (1957) and Albert and Maples (1995). Vertebral ring epiphyseal unification was observed from the anterior as well as the superior and inferior sides of the vertebral body. While examining the vertebrae, the authors realized that Albert and Maples' (1995) description of unification of the epiphyseal rings related only to the fusion of the external margin of the ring to the vertebral body, while fusion of the internal rim of the ring was not observed.

The remains used in this study comprise individuals killed during ethnic cleansing actions in 1992 in Krajina, in northwest Bosnia. All of the individuals examined for this study were exhumed from mass graves in the Krajina, between 2001 and 2005. For this study, a series of six vertebrae from 360 skeletal remains representing males of known age were examined. For each individual, the last three thoracic (Th10 – Th12) and first three lumbar (L1 – L3) were examined. The remains were completely skeletonized. The process of decomposition of soft tissues and skeletonization was natural and all examined vertebrae were dry, showing no trace of soft tissue (e.g. free of intervertebral cartilage and periosteum), which enabled the observation of changes in fusion of the vertebral rings. Three features at the vertebrae bodies were examined: fusion of the internal rim of epiphyseal rings observed from posterior (dorsal) view, changes in shape of the superior and inferior edges of the vertebral body and changes of texture of the superior and inferior surface of the vertebral body. Each vertebra was scored according to the presence and development of those three features with age.

A comparison of real and estimated ages of identified remains has shown that age-related changes observed in the vertebral column can contribute significantly to narrowing estimated age ranges, especially for individuals between the ages of 25-45 years, who constitute the majority of the missing from Bosnia and Herzegovina.

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Age Related Changes, Aging Techniques, Forensic Anthropology

H18 Progression of Intra-Epiphyseal Union and its Predictive Capability in Fragmented Remains

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The goal of this presentation is to document the progression of intra-epiphyseal union for the major long bones of the limbs. Statistical analysis will be used to support progression patterns for confidence in the forensic context.

This presentation will impact the forensic community and/or humanity by presenting a new and innovative method for the analysis and re-association of commingled and fragmented juvenile remains. Understanding the pattern by which union progresses in an epiphysis

offers the ability to reasonably predict the possible range of maturity of the entire epiphysis based on a recovered fragment. Once biological maturity of that epiphysis is assessed then re-association with similarly mature material is permitted.

Commingle and fragmentary remains pose specific problems in the analysis and description of human skeletal remains. The loss of key skeletal features commonly used to indicate sex, age, stature or race can hinder the ability to establish biological profiles and therefore the accurate reassembly of individuals. However, if a biological indicator is only partly missing, the part remaining may yet provide sufficient evidence to predict the condition of the missing fragments, thus still allowing some viable indication of biological identity.

Understanding the temporal sequence in which the various epiphyses of the body unite can be useful for re-associating bones from individuals of similar chronological age, but perhaps different maturity status (Schaefer, 2006). However, if only part of an epiphysis is present, the maturity assessment of the epiphysis as a whole may be skewed if the full pattern of fusion options is not fully understood. For example, if an epiphysis that is actively fusing becomes fragmented and the only fragment of bone that is recovered displays complete union, then the temptation will be to assume that the entire epiphysis has fused. This will inevitably lead to an over assessment of age and potentially incorrect biological profile and/or impede reassociation of parts. However if it is known that this is the first part of the epiphysis to commence union, then the range of possible ages can be extended to reflect the precocious nature of this feature. The fusion status of the fragment may provide useful ranges of potential maturity for the epiphysis as a whole if the sequence in which union progresses through the epiphysis is fully understood.

Progression of union was documented on a sample of 73 Bosnian males by recording the status of intra-epiphyseal union around the periphery of the bone. This was achieved by functionally dividing the epiphysis into segments in much the same way as a two dimensional map documents three-dimensional objects. The epiphysis was conceptually "unrolled" into a flattened continuous scale so that it was possible to visually record the location where peripheral union had, or had not, taken place.

Intra-epiphyseal progression was established for the epiphyses of the proximal humerus, ulna, femur and tibia, the distal radius, femur and tibia and the ischial tuberosity. Progressions patterns were first determined using observational analysis and were later confirmed through statistical analysis. Mathematical computations required that the visual data be transformed into a numerical format. Each segment of an epiphysis was assigned a score between zero and four depending on its degree of fusion (0 = no union, 1 = less than 1/3 union, 2 = around half union, 3 = more than 3/4 union, and 4 = complete union). A Kruskal-Wallis Analysis of Variances was then performed comparing each segment of an epiphysis to each of the other segments of that same epiphysis. If the mean scores between any of the two segments displayed a statistically significant difference then it could be inferred with some confidence that the union status of one segment was either in advance of, or retarded to, the other segment.

The results of this analysis show that the first and or last areas to unite on an epiphysis are frequently statistically different from the other segments of that epiphysis indicating that there is a predictive progression to intra-epiphyseal maturation which may be of sufficiently significant value to aid in the assessment and reassociation of fragmented remains.

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Epiphyseal Union, Commingled Remains, Bosnia

H19 Age Determination From the Medial and Lateral Clavicle: A Re-Evaluation of Present Scoring Systems

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After attending this presentation, attendees will become aware of the differences between various scoring systems used to determine age from the medial clavicle and will understand the usefulness of applying a transition analysis to this aging method. Additionally, this presentation will explore the lateral clavicle as a useful aging tool.

This presentation will impact the forensic community and/or humanity by demonstrating the necessity for continual updating of the samples from which standards are developed and a re-evaluation of methods, updating of samples and using modern data to assess age of modern skeletons.

The *Daubert* decision has made rigorous testing and evaluation of forensic methods essential in all fields of the forensic sciences. In forensic anthropology, the documentation of secular change in human skeletal dimensions necessitates continual updating of the samples from which standards are developed. This research answers the call for the re-evaluation of methods and updating of samples.

Background: The medial end of the clavicle is the last epiphysis to fuse in the human skeleton. This epiphysis remains unfused into adulthood, sometimes into the late twenties. Furthermore, whereas limb bone epiphyses can fuse in as little as 1 year, union of the medial clavicle takes at least 2 to 3 years¹. Consequently, the medial clavicle can provide accurate age estimates of young adults.

Early attempts at developing a scoring system include those of Stevenson² and Todd and D'Errico¹. Today, most anthropologists rely on McKern and Stewart's³ system developed using the Korean War sample of American males, Webb and Suchey's⁴ system developed using an autopsy sample from Los Angeles county, and/or Black and Scheuer's⁵ system developed using 18th, 19th, and 20th century skeletons from three European collections.

Typically, transition analysis is used to analyze senescent changes in bone⁶, but the medial clavicle is a good candidate for such an analysis because the extended development of this epiphysis is represented in a series of stages. In this study, transition analysis shows the average age at which an individual transitions from one stage to the next.

Methodology: This study's sample is a subset of the University of Tennessee's William F. McCormick Clavicle Collection, a modern autopsy collection assembled between 1986 and 1998. The sample consists of 563 individuals born between 1962 and 1983 (424 males and 139 females). The individuals were between the ages of 12 and 33 at the time of death. Ninety-five percent of the sample is Caucasian, 4% is African American, and the remaining 1% are Asian, Latino, and Indian.

The lateral clavicular epiphysis was scored as "not fused", "fusing", or "fused". The medial clavicles were scored with Todd and D'Errico¹, McKern and Stewart³, Webb and Suchey⁴, and Black and Scheuer⁵. The McKern and Stewart system was found to be the most comprehensive in estimating stage of union. This scoring system utilizes 5 phases: 0=no closure, 1=beginning union, 2=active union, 3=recent union with scar, and 4=complete union with no scar. The other systems were either lacking an important phase or included phases that could not be evaluated on this skeletal sample. Consequently, a transition analysis was performed on the McCormick clavicle sample using this scoring system, as well as on McKern and Stewart's data for the medial clavicle. Additionally, a transition analysis was performed on the McCormick data for the lateral clavicle using the 3 stages mentioned earlier.

Results and Discussion: According to the transition analysis of the lateral epiphysis, the average age at which an individual goes from "no

fusion” to “fusing” is 17 years. The average age at which an individual proceeds from “fusing” to “fused” is 19 years. There were no significant differences between males and females. The earliest age at which fusion began was 17 years. All individuals were fused by age 23.

The transition analysis produced the following results for the medial clavicle:

Transition	McKern and Stewart Males	McCormick Males	McCormick Females
Phase 0 to Phase 1	19.81 ± 0.22	16.95 ± 0.34	14.77 ± 0.65
Phase 1 to Phase 2	21.82 ± 0.22	20.42 ± 0.27	19.07 ± 0.48
Phase 2 to Phase 3	23.59 ± 0.26	24.28 ± 0.25	23.28 ± 0.47
Phase 3 to Phase 4	26.23 ± 0.32	27.21 ± 0.22	27.06 ± 0.40

These results show that differences exist between males and females concerning the average age at which fusion commences (Phase 0 to Phase 1); specifically, fusion begins earlier in females. Furthermore, the McKern and Stewart sample and the McCormick sample show differences in the first two transitions. The McCormick individuals begin fusion earlier than the Korean War males. This difference could be due to secular change in growth. Therefore, these results show the importance of modern data to assess age of modern skeletons.

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Age Estimation, Medial Clavicle, Transition Analysis

H20 Forensic Age-at-Death Estimation From the European American Male Sacrum: A New Component System

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The goal of this presentation is to demonstrate a new method for determining age-at-death from the human sacrum.

This presentation will impact the forensic community and/or humanity by introducing another researched skeletal region, increase the potential of age-at-death assessment, and demonstrate the utility of a new sequentially-coded component system, allowing for a greater understanding of the morphological gestalt than previous “summing” component systems.

The present contribution describes a newly developed sequentially coded component system for evaluating seven morphologies of the human sacrum in the production of statistically valid chronological age estimates.

Accurate age-at-death estimation from human skeletal attributes is critical for establishing a comprehensive and forensically significant

biological profile of an unknown individual, which in turn facilitates the victim identification process. The introduction of novel techniques for reliable estimation of chronological age from previously unresearched skeletal areas represents a valuable contribution to the field for a number of important reasons: 1) it enhances the capability of assessing age in incomplete, fragmented, and/or commingled sets of human remains, especially in cases in which other diagnostic areas may be lost or taphonomically altered; and 2) by increasing the number of skeletal areas studied in the unknown individual, new age estimation techniques often serve to narrow the confidence intervals of the final age assessment. This is particularly valuable when new techniques provide accurate age estimates for later adult stages, as degenerative processes show a much higher population variability in comparison to the developmental processes, typically resulting in wider confidence intervals.

The primary aim of this study was to determine whether morphological changes observed in the auricular surface of the sacrum and associated structures (seemingly mirroring the degenerative aging processes observed in the conjoining structure of the ilium), could be statistically correlated with chronological age. The sacrum is particularly useful for age estimation in that a number of clearly defined developmental changes (such as fusion of the first sacral vertebral body epiphysis) continue well into adult life of the individual. Therefore, evaluations of morphological changes documenting both degenerative and developmental stages might be combined to produce a new, more precise analytical technique for estimating age at death from the sacrum.

The first phase of the present study consisted of the analysis of a sample of 109 sacra of European American males from the early 20th century Hamann-Todd Collection (Cleveland Museum of Natural History, Cleveland, Ohio), to assess age-trait correlations and develop the morphological stages and confidence intervals associated with the new method. Seven developmental and degenerative non-metric traits of the sacrum were studied including: fusion of sacral body elements 1 and 2, fusion of sacral body elements 2 and 3, degree of auricular apical lipping, state of auricular surface epiphyseal fusion, first sacral vertebral body epiphyseal union, auricular surface microporosity, and auricular surface macroporosity.

Originally, each morphological character was scored according to multiple trait variants (3-5 character states), similar to those employed in age determination from the ilium. However, the initial results demonstrated that in most cases the intermediate trait stages did not significantly contribute to the accuracy or precision of the age estimates, when compared to those obtained by coding most traits as binomial variables (i.e., on a presence-absence basis). This significantly simplifies the scoring system and serves to reduce inter-observer error.

The results of the initial phase of the study suggested that by including both developmental and degenerative features in the analysis, the seven traits could be sequentially arranged to reflect the differential timing of significant aging events (i.e., clearly defined age-correlated morphological changes). Consequently, a sequential coding component system was developed in which coding scores for each of seven traits were arranged to produce a seven-digit score. The order of appearance of each trait within the seven-digit score was calculated to maximize the Spearman’s rank correlation coefficient of the code with age. Rank order statistics were selected to obtain a coding system in which a higher score in the seven-digit code corresponds more frequently to an older individual. Each unique seven-digit component score was then translated into a verbal and graphic description of the combination of morphological traits (morphological stage) and associated with an appropriate statistically validated chronological age interval (68 and 95% probabilities).

The new analytical method was tested on an independent sample of modern sacra from the William M. Bass Donated Collection (n=150), housed at the University of Tennessee, Knoxville. The method proved to be forensically accurate when tested on this independent sample.

This research indicates that the sacrum can be used to reliably estimate age-at-death in European American male individuals.

Age-at-Death Estimation, Sacrum, Forensic Anthropology

H21 Accuracy of Age Estimates Using the Pubic Symphysis

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The goal of this presentation is to report the accuracy of three methods of age estimation, based on the metamorphosis of the pubic symphysis as assessed by advanced student and professional forensic anthropologists, and promotes the continual self-evaluation of extant methodologies.

This presentation will impact the forensic community and/or humanity by demonstrating the results of this study that support the usefulness of age estimates based on the pubic symphysis and should positively impact the methods of choice in the application and practice of forensic anthropology.

During the 26th Annual Meeting of the Mountain, Desert and Coastal Forensic Anthropologists (Lake Mead 24 – 26 May 2006) a workshop was held on the parameters of age assessment from the pubic symphysis. Backgrounds, samples and general rationale were presented for the methods of Todd, McKern and Stewart, Gilbert and McKern and Suchey and Brooks. The meeting participants were then divided into eight groups. Each group was given 10 pubic bones. Each individual scored each of the 10 bones by the method they were most familiar. The scoring sheet required which method or technique was used and the number of years experience working with aging techniques (5 year increments). The remainder of the scoring sheet had columns for recording the pubic symphysis identification number, age estimate (either years or phase), known age, and difference between the estimated age and the known age. Reprints of articles of the different methods were available and standard pubic symphysis casts were available for the Suchey-Brooks and the Gilbert-McKern methods. Illustrations were available for the Todd method.

The pubic bones used in this study were part of the Teixeira autopsy collection dating from 1982 and 1983. Age is known for all specimens, and sex and ancestry are known for most specimens (68.75%). At the time of collection the pubic bones were cut parallel to and 1 to 1.5 cm away from the symphysis surface. Therefore, there is little or no inferior ramus, certainly not enough to accurately assess sex. The known ages of the pubic bones for each group varies, but each set of ten pubic symphyses has the same number of samples in each decade from the second through the seventh decade. The known ages in this sample range from 17 to 82 years. Eleven females and 44 males are in the sample, but equality of sex was not considered when generating the eight sub-groups. The basic sample held a variety of recorded ancestries: Negro = 6; White = 33; Mulatto = 11; and Japanese = 5. As such, sex and ancestry distributions were neither noted nor controlled.

Summary statistics were generated from the workshop scoring sheets as reported in Tables 1 and 2. The breakdown of years of experience, the method of choice, range of error and the best single and mean estimations are presented. The mean years of experience fell in the category of less than 10 years (roughly 9.7). The mean error without regard to the method used was 11.58 years.

Table 1. Summary statistics, experience.

Experience	Number of		Method Used	
	Individuals	Suchey-Brooks	Todd	McKern-Stewart
<5	25	20	4	1
<10	3	2		1
<15	3	2		1
<20	1	1		
>20	8	5	3	
Totals	40	30	7	3

Table 2. Summary statistics, data.

	Number Using Method	Mean Years Exp.	Mean Error ME	Stand. Dev. SD	Least Error (Best method Performance)
Suchey-Brooks	30	9.16	11.8	3.31	7.4
Todd	7	11.89	9.5	3.34	5.9
McKern-Stewart	3	8.75	14.3	5.95	8.3
All Methods	40	9.7	11.6	3.65	5.9

In this test of accuracy of individuals and methods, the greatest accuracy (lowest error rate) of all participants was 5.9 years seen in two individuals. Both used the Todd method and each had 15 or more years of experience. The lowest error rate using the Suchey-Brooks method was 7.4 years, accomplished by an individual with less than 5 years experience. The best error rate using the McKern-Stewart method was 8.3 years by an individual with less than 10 years experience. An error rate in the neighborhood of 7.0 years or less is considered excellent and suggests a performance level as well as or better than, published standard errors of those who derived the methods. Mean errors much above 7.0 years should probably be mentioned when reporting age estimates based solely on observations of the pubic symphyses face. Self-testing on one or more methods would be of benefit as well.

This study was made possible through the generosity of Dr. Judy Suchey for providing reprints of her aging materials and a number of Suchey-Brooks pubic casts and to Beth Miller for transporting these materials to the MD&C meetings at Lake Mead. The enthusiasm of the participants in this study should also be acknowledged.

Skeletal Age, Pubic Symphysis, Methodologies

H22 A Reevaluation and Revision of the Suchey-Brooks and Loth and Iscan Aging Methods

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After attending this presentation, attendees will learn about revisions made to two existing adult aging techniques as well as about a new collection of skeletal elements available for analysis.

This presentation will impact the forensic community and/or humanity by providing revisions to two of the more commonly used methods for estimating age at death in adult skeletons. The new revisions should increase the accuracy of age at death estimates so that age ranges given in reports will be more precise.

Determining age at death is a critical step in the process of establishing positive identification of human skeletal remains. While forensic anthropologists utilize a number of skeletal aging techniques, two of the most commonly used standards include those for the pubic symphysis on the pelvis and the sternal ends of the fourth rib. These techniques are widely accepted and are applied to both modern and ancient human skeletal remains around the globe. The three objectives of this research are (1) to evaluate the current standards on a large, modern, and diverse sample, (2) propose revisions that increase the accuracy of each method, and (3) establish a new, documented sample for future research and education.

From January 11, 2005, through June 30, 2006, skeletal specimens were collected from decedents of known age, sex, and race during examination at the Maricopa County Forensic Science Center (FSC) in Phoenix, Arizona. Consent from next of kin was obtained in compliance with the protocol previously submitted to and approved by the Arizona State University Human Subjects' Institutional Review Board, and was recorded. Thousands of phone calls were placed, but due to a variety of factors including language barriers, 1123 individuals were actually

contacted. Of those, 725 consented to participate in this study, while 398 declined participation. Unfortunately, due to reasons such as disease, examination conditions, and other restrictions, the bone segments of 165 decedents for which permission was granted were not removed during examination and are not included. The sample also includes bone segments that were retained in Forensic Anthropology cases and unidentified individuals (N = 44), and from Barrow Neurological Institute (N = 24). Ultimately, viable bone segments from 630 individuals were obtained.

The collection amassed consists of pubic symphyses and fourth rib ends from 419 males and 211 females, ranging in age from 18 to 99 years of age at death. The average age at death of the females in the sample is 59.1 years and the average age of the males is 52.6 years. Individuals classified by the medico-legal system at the FSC as Asian, Black, Caucasian, and Native American are represented. A comprehensive database was created in Microsoft Excel that contains the pertinent biological information about each specimen (age, sex, race, etc.), drug and alcohol abuse history when available, and any other important information.

Age was estimated using the Suchey-Brooks and Yücan and Loth methods. Correlation and contingency table comparisons between actual ages and estimated ages were performed as well as comparisons between the accuracy of the rib and pubic symphysis, and inter- and intraobserver error. The correlation results indicate that there are significant differences in the observed vs. actual ages in both the ribs ($r = 0.75329$, $p < 0.001$) and pubic symphyses ($r = 0.68169$, $p < 0.001$). Two volunteers with differing levels of experience also scored a subset of the whole sample (N = 100). These correlation results suggested that there were significant differences in the observed vs. actual scores for the two volunteers (vol. 1 pubic symphysis $r = 0.58048$, $p < 0.001$ and rib $r = 0.72027$, $p < 0.001$; vol. 2 pubic symphysis $r = 0.69936$, $p < 0.001$ and rib $r = 0.65517$, $p < 0.001$). A CROSSTABS analysis was conducted to determine how many individuals were under- or over-aged using both phase methods. Intraobserver tests did not produce significant results.

Next, the pubic symphyses and rib ends were seriated and sorted separately based on morphological characteristics without prior knowledge of the age at death. The female and male ribs were each placed into seven distinct morphological groups. New descriptions and age ranges were created and tested. The male and female pubic symphyses were also segregated into seven phases. A late phase, phase seven, was described for both males and females, and is comprised of individuals over 70 years of age at death. Summary statistics were calculated for each phase and descriptions for each phase were created.

Based on the samples collected during the grant period, this study will build on the innovative work of earlier anthropologists who established the accepted aging standards utilized in forensic anthropology and bioarchaeology today. The current standards were developed after a great deal of effort and scientific insight on the part of the researchers. Although adequate, the methods are problematic due to sample size and statistical issues. Furthermore, the research collections from which the aging standards were developed are not easily accessible. Thus, this research has created a new, large, and modern documented sample that will be available for study and retesting.

Pubic Symphysis, Sternal End of Fourth Rib, Aging

H23 Age Estimation From the Posterior and Middle Part of the Ilium

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The goal of this presentation is to describe a revised method for estimating adult age at death using the auricular surface and the acetabulum.

This presentation will impact the forensic community and/or humanity by demonstrating a revised method using the acetabulum and the auricular surface that preserves the *os coxa* and can be used on a large population with known ages.

Introduction: The study of the posterior and middle part of the pelvis is of interest in forensic anthropology since it is an anatomical region that is very often preserved. The Lovejoy technique, using the auricular surface, has brought about many studies and attracted many authors foremost among them Buckberry and Chamberlain who utilized the criteria described by Lovejoy and developed new methods. By using this research as a starting point, in a preliminary study, acetabular criteria was described. The goal of this new study was to test these acetabular criteria and to link them to auricular surface reading criteria, as described by Buckberry and Chamberlain.

Method: The study concerned 463 *os coxae* of known age and sex from Caucasian individuals (identified collection of Coimbra – Portugal). The examiner was not aware of the age of the bodies when assessment was made. Four criteria with the auricular surface were described, using Buckberry and Chamberlain's method. The features used were transverse organization, surface texture, porosity and changes in the morphology of the apex. Each of the features was recorded independently and assigned a series of numerical scores corresponding to successive stages of degrees of expression. Concerning the acetabulum, three criteria were isolated: appearance of the acetabulum rim, appearance of the acetabulum fossa and apical activity. These criteria were observed and assigned a series of numerical scores corresponding to successive stages of degrees of expression. The age correlation of various criteria read at the acetabulum level and that of the auricular surface were studied. SPSS (software package for statistical analyses) were applied to evaluate the data. To argue the appropriateness of the variables and quantify correlation with age, Kruskal-Wallis tests were calculated. Mean, standard error and standard deviation have been considered. Intra- and inter-observer variability was also studied. A paired t-test was calculated for 114 individuals with both left and right auricular surfaces present. The difference between males and females with a regression line for both data sets was tested and a Spearman's correlation coefficient was calculated.

Results: Kruskal-Wallis statistics to quantify the correlation of each criterion with known age at death were all significant. This correlation is better once a score is established corresponding to the sum of ratings for the various criteria. Similar observations can be made regarding acetabulum criteria. Studying the correlation between the overall score (sum of acetabulum and auricular surface scores) and age is of interest. The method was tested for intra-observer error. Results are better when the overall score is studied. It's the same thing with the inter-observer error. There were no significant differences between ages for males and females and between sides.

Several total scores were found to have similar ranges, distributions and mean ages (using Buckberry and Chamberlain's method). These scores were grouped together to produce seven stages for the purposes of age estimation. A Bayesian analysis was used to provide probability of age, given the stage.

Discussion: Four acetabular criteria and four auricular surface criteria were isolated which have a correlation with age. Establishing these scores (sum of criteria) allows a better age-based correlation to be obtained. Establishing an overall score, including acetabular criteria and auricular surface criteria, allows a good level of correlation to be obtained with age, with low intra- and inter-observer variability. Several total scores to define a method were established. It has been shown that there is no significant difference between sexes and sides.

Conclusion: The study of the acetabulum is of interest for the age estimation of adult subjects. The joint study of the acetabulum and the auricular surface allows a higher correlation with actual age to be obtained.

The revised method using the acetabulum and the auricular surface is interesting. It's easier to apply and has low levels of inter- and intraobserver error. The method outlined here needs to be tested using a large, multiracial known-age population.

Skeletal Age at Death, Auricular Surface, Acetabulum

H24 Bones in Aid of Forensic Pathology: Trauma Isn't Only Skin Deep

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After attending this presentation, attendees will understand how the forensic anthropologist could assist the pathologist in the autopsy room in some cases in which soft tissues are not sufficient to understand the mechanism of the wound.

This presentation will impact the forensic community and/or humanity by demonstrating how the recent demands of forensic science have paved the way for forensic anthropology to assume multiple functions in understanding cause and manner of death.

Introduction: Traditionally the role of forensic anthropology as a legal discipline has focused strictly on the study of skeletal remains. However, recent demands of forensic science have paved the way for forensic anthropology to assume multiple functions in understanding cause and manner of death.

The role of the forensic pathologist is to examine all tissues at autopsy in fresh or putrefied cadavers, but rarely do they have time or expertise to closely examine bone. Anthropologists can assist in filling that gap to produce essential information at autopsy. In many cases, bony characteristics of trauma may be more revealing and less deceptive than soft tissues. That being said, autopsies should not stop with descriptions of soft tissues and cursory descriptions of the skeleton. The areas involved with bony trauma should be removed and processed free of soft tissues for a proper examination and documentation. This presentation will introduce numerous case studies that demonstrate the utility of bone removed from autopsy as evidence, and demonstrate how bone lesions contribute to a more accurate understanding of the cause and manner of death.

Materials and Methods: Case 1. A well-preserved 35-year-old Caucasian male arrived at the morgue with multiple stab wounds to the head and thorax. The skin lesions presented with linear cuts at 90° or acute margins. After being cleaned, an examination of the underlying skull cap showed the presence of triangular puncture wounds under the overlying apparent linear cut wounds. The offending instrument was, in fact, a pick with a pointed but triangular cross-section.

Case 2. A slightly putrefied 70-year-old Caucasian female was found dismembered. Soft tissue analysis revealed illegible putrefied margins of cuts adjacent to the dismembered areas and irregular linear lacerations on

the parietal region. Cleaning the bones showed the effect of blunt force injury on the head and saw mark analysis on the bone revealed characters of the saw used for the dismemberment.

Case 3. A well preserved 40-year-old Caucasian male died after being hit by a car. The legs showed only blunt soft tissue lesions, mainly lacerations. After removing the soft tissue, the analysis of the underlying tibia and fibula showed a butterfly fracture, crucial in reconstructing the direction of the impact.

Case 4. Two male Caucasian 30-year-olds, slightly putrefied, were found with illegible lacerations on the skin of the head. Cleaning and reconstructing the entire skull allowed for the interpretation of the exact site of impact, minimum number of impacts, and even the chronological order of the blows.

Case 5. The charred remains of a 30-year-old male were recovered. Nothing could be seen on the burnt head. However, reconstruction of the fragments of cranium showed clear signs of a typical burning and definite signs of trauma.

Results and Discussion: These cases illustrate the utility of skeletal examination at autopsy and demonstrate the value of trauma examination in bone as major contributors to the final and accurate analysis of cause and manner of death.

Forensic Anthropology, Trauma Examination, Pathologist

H25 Propeller Impacts: Injury Mechanics and Bone Trauma

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After attending this presentation, attendees will gain an understanding of the mechanics of injury in propeller impacts to the human body as they relate to speed of impact and propeller design.

This presentation will impact the forensic community and/or humanity by increasing the understanding of the correlation between impact speed and resultant fracture patterns, and the correlation between propeller design and soft and osseous tissue damages.

Numerous swimmers are injured or killed every year due to impact from boat outboard motor propeller strikes. Even boats traveling at relatively low speeds can create large amounts of soft tissue and bone damage. These wounds often bear characteristic patterning of longitudinal impact zones in both bone and soft tissue; useful to both forensic pathologists and anthropologists in determining cause and manner of death. While propeller impacts are fairly easily recognized, the exact injury mechanics have received comparatively little attention. Differences in propeller design, boat velocity, and motor rpm influence the resultant injury patterns – leading to conflicting opinions in the forensic community over the “classification” of propeller impact as either blunt or sharp trauma.

Injury mechanics associated with propeller impacts were investigated, as well as the differences created by *speed* and a *propeller alternative design*. Ten cadaveric specimens were used for the testing (4 human and 6 porcine). Two tests were conducted per specimen, resulting in a total of 20 tests. The human tests were conducted at speeds of approximately 5 to 7.4mph (with increasing propeller spinning speeds respectively). The porcine tests were conducted at speeds of approximately 1, 5, 7.4, and 15 mph (with propeller spinning speeds increasing respectively again). Two different propeller designs were examined in testing. One was a standard propeller design, with three blades of aluminum. The other was a “ring-style propeller” – a propeller in which all the tips of the three blades are joined together by an aluminum ring.

The human cadavers (recently deceased) were frozen post-mortem as “fresh specimens” (i.e. no preservatives were used) until thawed at the time of the tests. Specimens were refrigerated until a few hours before testing. Just prior to testing, each human specimen was fitted with swim attire and a mask. Porcine cadaver specimens were euthanized shortly before testing. Testing was performed in a unique facility at The University at Buffalo, part of the State University of New York system. The Center for Research and Education in Special Environments (CRESE) provides a controlled environment that allows for safety, privacy, and repeatability such that real-world boating accidents could be simulated as closely as possible. The facility houses a toroidal pool that is 8’ wide, 8’ deep, and 200’ in circumference. The water was maintained at 73 degrees F throughout the testing. A large centrifuge is located at the center of the pool and a platform is suspended over the pool from the centrifuge arm. An outboard boat motor was mounted to the platform. Instrumentation allowed for inputting and recording of motor travel speed and RPM. The motor was towed at 5 or 7.4 mph around the pool to the impact site for the human tests. The motor was towed at 1, 5, 7.4, and 15 mph around the pool to the impact site for the porcine tests.

Each of the tests was recorded with standard and high speed video (1,000 f/s). The high speed video was essential in understanding the mechanics of the injury and the interaction between the cadaver and the boat propeller. A difference was seen between the standard propeller and the ring style propeller in how the body was engaged by the blades.

Post-test dissection showed classic multiple parallel lacerations and numerous vertebral, rib, and skull fractures for the standard prop tests. At these low speeds the standard prop gives rise to incisive, sharp-force injuries that affect both soft and osseous tissues (skull, face, ribs, scapula, and vertebra). The standard prop, in longitudinal impacts at just under 8 mph, produced life-threatening injuries. The ring-style propeller imparts more of a scooping-like blunt trauma that, at worst, results in large lacerations and avulsions that appear, in the four human cadavers, to only affect the superficial tissues. That is, at these low speeds, the ring-style propeller seems to kind of “bite” or “scoop” the superficial skin and fatty layers while primarily scooting/pushing along the muscles and bones, whereas the standard prop penetrates deeper and into the muscles and bones.

The injury mechanisms behind propeller strikes are complicated, as are most violent impacts to the human skeleton. However, controlled experimental testing can provide an increased understanding of the effects of speed of impact, as well as propeller design. Testing showed that both of these variables do influence the injuries to soft tissue, and the fracture patterns in bone.

Bone Trauma, Experimental Testing, Propeller Impact

H26 Standardizing Saw and Knife Mark Analysis on Bone

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As a part of a series of presentations covering toolmarks on bone, the goal of this presentation is to discuss toolmark relevance, particularly in a court of law. Earlier presentations (Symes, Kroman et al. 2006; Symes, Rainwater et al. 2006) classified major approaches and common pitfalls regarding toolmark analysis while promoting the use of tool class characteristics. This presentation will identify and explore historic misperceptions regarding toolmarks, introduce a systematic approach for the analysis of toolmarks, present initial results of toolmark examination produced by a series of new mass-produced saws, and discuss the relevance of these changes to future toolmark analysis.

This presentation will impact the forensic community and/or humanity by demonstrating a standardized, systematic approach to toolmark analysis on bone will promote cohesion among forensic professionals thereby enhancing the resolution of skeletal trauma evidence.

Forensic anthropologists – once limited to traditional identification issues – are becoming more involved in investigations of death events, directing their expertise to the analysis and interpretation of traumatic injuries and taphonomic influences. This broadening role is evident in forensic anthropology’s contribution to cases of dismemberment and mutilation.

The evidentiary value of toolmark analysis in these cases is compelling. However, its potential at times is impeded by a lack of interdisciplinary research and communication among anthropologists, pathologists and criminalists.

Anthropologists (osteologists) are uniquely qualified to examine defects in bone but lack a background in toolmark examination. Pathologists commonly work with marks created by tools, but rarely have time to devote to this specialized analysis. Likewise, criminalists are not usually positioned or equipped to examine fresh specimens removed from the recently deceased. The objective of each professional is the same; to narrow the possible range of tools used in a crime and assist investigators in narrowing their search for the tool(s) used in the commission of a crime. Nevertheless, each profession remains generally unaware of the others’ efforts and advances.

This glaring discrepancy is compounded by the fact that forensic toolmark research appears to have stagnated in the midst of a forensic climate that demands a closer look at ignored or unrealized evidence.

Historically, disregard for toolmarks on bone is enhanced by misperceptions that analysis fails to produce significant information in an investigation. This flawed thinking can be traced to two sources.

First, the archaic view that every pass of a saw tooth on bone erases the marks left behind by the previous tooth has resulted in an inherent error in the standard approach to saw mark analysis. While this view may reveal limitations in individual characteristics, it essentially disregards the vast potential of “class characteristics.”

Second, traditional anthropological approaches are outdated with the advent of the anthropologists’ relatively new and evolving association with the recently dead. Hypotheses developed for historic or prehistoric peoples serve a different purpose than those analytical results developed in a modern forensic case.

While it is tempting to examine toolmark striae for generic patterns or striation frequency, these uninformed approaches will likely be subjected to subsequent judicial scrutiny where admissibility may be challenged based on accuracy, reliability of the technique, replicability, and absence of validation studies. The repercussions of an ‘academic’ as opposed to an applied forensic approach can be nothing short of an obstruction to justice.

This presentation will outline experimental approaches to researching toolmarks on bone while outlining methodologies for the examination, analysis, and documentation of such marks. Saw mark class characteristics will be systematically analyzed in order to produce tool descriptions that may be useful when presented in court. This approach is simplified in order to standardize methods and to make features more recognizable. This simplified approach is attempted despite the fact that mass-produced “junk” saws lack conformity to age-old saw manufacture standards. In the end, toolmark analysis on bone with guidelines, standards, and the appropriate equipment should result in productive answers to the frequently asked question: *what is the potential of toolmark analysis in dismemberment interpretation?*

References:

¹ Symes, Steven A., and Anne M. Kroman, Susan M. Thurston Myster, Christopher W. Rainwater and John J. Matia, 2006, Anthropological Saw Mark Analysis on Bone: What is the Potential of Dismemberment Interpretation? Paper presented at the 59th Annual Meeting of American Academy of Forensic Sciences, Seattle.

² Symes, Steven A., and Christopher W. Rainwater, Susan M. Thurston Myster and John J. Matia, 2006, Tool Mark Analysis of Knife and Saw Dismemberment. Paper presented at the 91st International Education Conference of the International Association of Identification, Boston.

Saw Marks, Dismemberment, Skeletal Trauma

H27 Ballistics-Induced Depressed Skull Fractures

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The goal of this presentation is to educate forensic scientists about the association of depressed skull fractures and a particular type of ballistic trauma.

This presentation will impact the forensic community and/or humanity through knowledge gained regarding another etiology for depressed skull fractures.

Ballistic trauma of the skull most commonly results in an interiorly beveled entrance wound and, if applicable, an exteriorly beveled exit wound. As will be discussed, certain types of firearm trauma can result in atypical bone injuries. The authors will present the case of a 28-year-old white female who died approximately 12 hours after presentation to the hospital for a reported perforating gunshot wound of the head. In support of this case and its findings, further corroborative case examples will be discussed.

The autopsy of the primary case revealed a thin white female with a bandaged head. Under the bandage, the hair was completely matted with blood, through which an irregular sutured wound on the top of the head was visible. Removal of the sutures revealed an irregular 1-1/2 inch abraded laceration on the left parietal scalp. An additional curvilinear 1/2 inch partial thickness laceration was just posterior and medial to the sutured wound. An oval skull depression was directly under and visible through the laceration. No obvious projectiles or lead wipe were present on the cranial radiograph.

Reflection of the scalp revealed hemorrhage encompassing the left frontal and parietal subscalpular tissue and a large subgaleal hemorrhage overlying both parietal bones. Removal of the subgaleal hemorrhage revealed a 1 x 7/16 inch oval depression fracture of the left parietal bone just posterior to the coronal suture. The concavity depth was approximately 3/16 inch. An "X"-like fracture pattern was in the depressed portion of bone and the lateral fracture margin had a 'stacked' appearance. The underlying brain had corresponding fracture contusions.

Given the depressed skull fracture, the lack of typical entrance and exit wounds on the skin, and the semi-circular laceration on the skin, it was initially felt that this injury was due to blunt impact trauma, possibly from the grip or butt of a gun. However, closer inspection revealed grey residue on the 'stacked' edge of the fracture. No firearm residue was grossly visible on or under the skin. Since the edges of the wound could not be re-approximated, the possibility of a tangential or graze gunshot wound was considered.

Police detectives brought the weapon in question to the Medical Examiner's Office the next day and the wounds were re-examined. The weapon was placed against the skin and the pattern of the semi-circular laceration fit the gun's muzzle end exactly. The initial report stated that two projectile casings, possibly felt to be 'old' were at the scene, but no bullets were recovered. Upon request, the scene was re-examined and two bullets were located, one of which had hair, blood and tissue on it. One edge of this bullet was flattened. Based on these findings, a tangential gunshot wound was confirmed.

Depressed skull fractures typically pose no significant dilemma for forensic anthropologists and pathologists with regards to the type of trauma involved, as they are typically associated with blunt force impacts. This case illustrates that ballistic trauma may also cause depressed skull fractures when the trajectory of the projectile is tangential to the bone. Typically, tangential or graze gunshot wounds result in a keyhole type

fracture with interior beveling on the entrance side and exterior beveling on the exit side. While unusual, if a bullet's path is extremely tangential, it can graze the skull without complete penetration, causing a depression fracture.

It is important for forensic anthropologists and pathologists to keep firearm trauma in mind when dealing with depressed skull fractures. Should only skeletal elements be available for examination (unlike the presented case), different conclusions could be drawn with regards to the source and type of the trauma, thereby potentially altering the investigation of potential suspects.

Depressed Skull Fracture, Tangential Gunshot Wound, Ballistic Trauma

H28 When the Bullet Hits the Bone: Patterns of Gunshot Trauma to the Infracranium

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The goal of this presentation is to survey the basic principles of gunshot trauma and its effects on bones of the infracranium. Attendees will also learn the intricacies of a graduate student's anthropology research project involving pig carrion and guns.

This presentation will impact the forensic community and/or humanity by addressing the lack of information involving gunshot trauma to the bones of the infracranium. In forensic anthropology today, there is a great amount of data surrounding gunshot wounds (GSW) to the skull. The orientation and composition of the squama allows for distinctive and predictable damage. However, the skull is not always the object of trauma in a homicide. Many times the only physical remains the anthropologist has to examine are sections of long bone or other portions of the skeleton. It is here that a dearth in information could be detrimental to the science. The overall goal of this project was to add an important section to the science of forensic anthropology with the understanding of gunshot trauma to the infracranium.

The amount of trauma sustained in a GSW is determined by the loss of a bullet's kinetic energy. Kinetic energy of the bullets is equal to half of its mass multiplied by its velocity squared, or $KE = (1/2)mv^2$. These variables were tested using weapons and ammunition with different calibers, weights, jacketing, and muzzle velocities. The three weapons examined were the AK-47, the .308 Winchester, and the 9mm pistol. These weapons were loaded with a .30 caliber 123-grain hollow point bullet, a .308 caliber 168-grain hollow point bullet, and a 147-grain bonded hollow point bullet, a 124-grain full-metal jacketed bullet, and a 115-grain non-bonded hollow point bullet, respectively.

Five pig carrion were shot under controlled conditions by an officer of the Comal County (Texas) Sheriff's Department. The pigs were radiographed and then macerated to examine the underlying osteological trauma. Both methods of examination supported the hypothesis that specific types of weapons and ammunition result in specific patterns of trauma. An overwhelming amount of trauma occurred on the bones of the pigs shot with the high velocity weapons, while the remains of the pigs shot with the low velocity weapon sustained relatively little fracturing.

After further examination, it will be possible to predict the amount of trauma incurred by specific guns and ammunition. With some standardization, it should be possible to utilize this information to infer class of weapon that results from ballistic trauma in forensic cases. The overall goal of this project is to add an important section to forensic anthropology with the understanding of gunshot trauma to the infracranial skeleton.

Gunshot Trauma, Infracranium, Kinetic Energy

H29 Controlled Fracture of Bones Before and After Degradation Under Different Environmental Conditions

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The goal of this presentation is to provide research results pertaining to the examination and comparison of perimortem trauma with subsequent weathering to postmortem trauma induced at increasing time intervals.

This presentation will impact the forensic community and/or humanity by providing additional information regarding the determination of ante-, peri-, or post-mortem bone trauma.

Mechanical strength of the bone and the appearance of the fracture site as a function of environmental conditions and exposure time will be presented. The authors hypothesized that the application of different treatment conditions would have differing effects on the mechanical properties, fracture mechanics, and appearance of bone. The objective of the study was to compare the fracture behavior and mechanical properties of bone under three degradation conditions during a four-month period of time. A mechanical test method was designed to simulate blunt force trauma from a pipe or crowbar.

The humerus (H) and fused radius/ulna (R/U) from the forelimbs of 18 sheep (*Ovis aries*), Rambouillet and Columbia crossbreds, were used. A custom-designed three-point bend test jig on an MTS 858 Mini Bionix II was used to break the bones. A one-inch diameter indenter modeled a standard crowbar and was used to inflict blunt force trauma to the midshaft of the bone in a cranial-caudal (i.e., anterior-posterior in the human) direction at a speed of 6 in/s. Three sets of bones served as controls and were broken after removal of soft tissues. One set of controls (H & R/U) and five additional sets were each set outside under the following conditions: 1) full sun, 2) shade, and 3) submerged in water. One set of bones (H & R/U) for each of the environmental conditions was broken at 1, 2, 4, 8, and 16 weeks. The experiment took place during the summer in central Texas (May to August 2006). Peak load (lbs) was measured for each bone. The fracture surface of each bone was photographed and analyzed using Scion Image to determine inner and outer diameter at midshaft in the medial-lateral and cranial-caudal directions. Total area of the bone was also calculated. These measurements were used to calculate stress in order to normalize the measurements to control of size differences between animals. A standard formula used to calculate the bending stress is $s = -Mc/I$. A simplifying assumption was made that the shape of the midshaft of the bone was elliptical.

Data from this study were compared to a preliminary study conducted in central Texas during the winter (November 2004 to February 2005). During the current test period, the average high temperature was 93.1°F, the average low temperature was 69.4°F, and the average daily rainfall was 0.054 in., and during the preliminary study the average high temperature was 63.0°F, the average low temperature was 42.7°F, and the average daily rainfall was 0.089 in. The mechanical properties of bone were significantly affected by environment in both studies and distinct

differences were noted between the appearances of ante-mortem vs. post-mortem trauma. The biggest differences in mechanical properties for the current study were seen at 2 weeks. The changes in mechanical behavior of the bones that were stored submerged in water appeared to be similar in both studies. However, for the specimens stored in the shade, the difference in temperature made a difference in the degradation of mechanical properties. The specimens that were tested in winter took longer to show a drop in peak load. Specimens that were exposed to the sun in the summer also showed a decrease in peak load much earlier in the study than those tested in the winter.

Bone, Blunt Force Trauma, Fracture Mechanics

H30 Abstract Withdrawn

H31 Sources of Error in Genetic and Osteological Sex Determination: Lessons from Physical Anthropology

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The goal of this presentation is to present forensic scientists with an understanding of the error associated with both the genetic and morphological based tests of sex determination, and to stress the fact that forensic scientists should employ and understand a wide range of scientific tools when analyzing human remains in a forensic context.

This presentation will impact the forensic community and/or humanity by introducing important information on the advantages and limitations of genetic and morphological sex determination, and will present a critical assessment of the interpretational error associated with the techniques using anthropological examples.

An important duty of the forensic scientist is to present their opinion in a judicial setting. An experienced expert witness should be prepared for conflicting opinions presented by opposing counsel. An opportunity for such a situation to arise may involve the determination of sex from skeletal remains. Determining sex from the skeleton can be accomplished by both morphological and genetic analyses. Forensic anthropologists are skilled at an osteological determination of sex and are aware of the error associated with interpretation of their analyses. Such investigations are extremely accurate when the entire skeleton is present for examination, and become more difficult as skeletal elements are missing and/or fragmented. Non-metric analyses examine sexual dimorphic differences in the size and shape of bones, and rely on the training of the investigator. Metric analyses employ classification based on measurements of various skeletal elements. Many forensic anthropologists use the discriminant functions in FORDISC software to classify the individual based on comparison to a data base of individuals of known sex. They should be trained in the interpretation of the results involved in classifications, should have a working knowledge of the statistical methods employed by FORDISC, and should understand that the probability of an individual being misclassified is not random.

Determination of genetic sex employs polymerase chain reaction (PCR) amplification of X and Y chromosome-specific DNA fragments of different sizes. Misclassification can occur with this test and has been attributed often to a deletion in the relevant area of the Y-homologue. Other interpretational issues include contamination, stochastic fluctuation, and preferential amplification. Laboratory contamination is rare; however, remains can become contaminated during collection. Stochastic fluctuation, or sampling error, and preferential amplification are both phenomena that may occur with the low quality and quantity DNA

associated with forensic evidence. Females have two X chromosomes and failed amplification of one X-homologue would still indicate a female. Males have one X and one Y chromosome. In a male sample, failed amplification of the X-homologue would raise concern, but would not lead to misclassification due to the presence of the Y-homologue. However, if the X-homologous fragments are preferentially amplified over the Y-homologous fragments, male samples would be misclassified as female. A forensic DNA analyst must therefore have the ability to analyze and interpret samples that are usually highly degraded, and must have an understanding of the physical evidence as well as the techniques used to analyze that evidence.

Genetic sex tests are automatically included in genetic identification tests like CODIS (combined DNA index system). With what is being called the “CSI Effect” the general public is over confident in scientific evidence, especially genetic evidence. There can be instances where morphological and genetic sex could provide conflicting results, and it is imperative that forensic experts understand the strengths and weaknesses of all of the scientific techniques involved in the analysis of skeletal remains.

Sex Determination, Osteology, Genetics

H32 Skeletal Markers of Parturition II: Reanalysis of a Modern American Sample

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After attending this presentation, attendees will learn that parity status cannot be inferred with accuracy from the bony pelvis, especially from the dorsal side of the pubis. The research presented here tested markers of parturition against known obstetric histories, and the results indicate that workers should not infer parity status from the *dorsalis pubis*.

This presentation will impact the forensic community and/or humanity by stressing that the inference of parity status from the bony pelvis should not be included as an aspect of the biological profile in forensic case reports.

The William M. Bass Donated Collection curated by the Forensic Anthropology Center at The University of Tennessee was utilized for this research. A previous version of this paper was presented at these meetings (Bethard 2004), and the authors wished to update and increase the dataset with recent female donations. The purpose of this study was to increase the knowledge of the correlation between dorsal pitting and pregnancy for all females of known parity status in the Bass Donated Collection. Female skeletons of known parity status (n=45) were scored for the degree of dorsal pitting of the pubis. Pits on the *dorsalis pubis* were scored as either absent, trace to small, or moderate to large (after Stewart 1970). Pubic bones scored as “absent” were unremarkable with regard to dorsal pitting while “trace to small” indicated the presence of shallow depressions. “Moderate to large” dorsal pits were a minimum of 5mm in diameter and noticeably deep. In addition, 150 paired male pubic bones in the collection were examined for changes described by Stewart (1970), Angel (1969), and other workers with the intent of demonstrating that there are factors other than pregnancy that can cause changes to the *dorsalis pubis*.

A thorough literature review indicates that workers have maintained mainly negative correlations between parturition and morphological markers of the *dorsalis pubis*. Stewart (1970) discusses Angel’s (1969) contribution to this issue, and hypothesizes that Angel would be wary of the use of his description of these morphological markers in forensic case reports. Stewart himself notes that, “some women can bear children ... without any scarring” and proposes the use of “extreme care” when analyzing forensic skeletons (1970). Suchey and colleagues (1979) found

that age and number of pregnancies were most important when analyzing the degree of dorsal pitting, and they also found 4 males out of a sample of 781 with moderate to large pitting. This indicates that while rare, there are factors that induce morphological changes on the *dorsalis pubis* other than pregnancy. More recently, Cox and Scott (1992) found that there was no relationship between pubic pitting and known parity status

Non-parametric chi-square analyses were performed on the female sample to test the relationship between parity status/pitting (P=.328) and pitting/age (P=.773). Such results corroborate previous findings that indicate a weak association between the presence of pitting on the *dorsalis pubis* and pregnancy. Such results also demonstrate that age-related changes of the *dorsalis pubis* do not have a significant effect on the presence or absence of pitting. Moreover, out of 150 paired male pubic bones examined, 4 males (2.67%) had “trace to small” changes on the *dorsalis pubis*, further indicating that the identification of factors other than pregnancy causing such changes could be a direction of future research.

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Parturition, Forensic Anthropology, Skeletal Biology

H33 Geometric Morphometrics of the Scapula: An Assessment of Ancestry

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After attending this presentation, attendees will understand the classificatory power of the scapula using geometric morphometric methods. An analysis of landmark data will be presented to assess the differences in the scapular shape of modern American white and black males. It will provide an alternative to traditional methods of ancestry determination that require the cranium or rely on simple linear measurements of the postcranial skeleton.

This presentation will impact the forensic community and/or humanity by demonstrating the classificatory power of the scapula and encouraging anthropologists to investigate the geometric morphometrics of other postcranial elements and their use in the determination of ancestry.

The determination of ancestry is an integral component of the biological profile generated by forensic anthropologists for unknown skeletal remains. The postcranium is regularly under-utilized for ancestry determination; this is due in part to the classification rate attributable to the cranium and mandible. Anthropologists have noted general differences in body form between populations, leading to the use of the postcranial skeleton for differentiating between populations using traditional linear measurements. However, the scapula is rarely used during ancestry determination and traditional linear measurements are generally limited to

the maximum width and height of the scapula. The current study builds on Snow (2004) and utilizes geometric morphometrics to explore the shape differences in modern American White and Black males as reflected in the morphology of the scapula.

To determine whether differences in shape exist between modern American White and Black males, 14 landmarks were taken on 76 individuals from the William M. Bass Donated Skeletal Collection curated at the Department of Anthropology, University of Tennessee, Knoxville, TN. Coordinate data were collected from the scapulae using a Microscribe 3DX digitizer (Immersion Corporation, 2002). A Generalized Procrustes Analysis (GPA) was performed using Morphologika (O'Higgins and Jones, 2006). A GPA analyzes landmark data by stretching and appropriately fitting the data through a transformation, rotation, and translation process (Rohlf, 1996). Morphologika outputs the principal components and residuals employed in subsequent analyses in SYSTAT. A thin-plate spline analysis of the group means demonstrated several differences in shape between Black and White males. In particular, Black males exhibited an increased concavity of the subscapular fossa, and a more superior and medially positioned glenoid fossa. Furthermore, the Black male sample demonstrates a substantial anterior projection of the coracoid process. To determine how well these differences in morphology discriminate ancestry groups, a discriminant function analysis (DFA) was performed on the first ten PC scores. Using only 10 PC scores reduces the dimensionality and avoids over-fitting of the data, while still accounting for most of the shape variation. The DFA produced significant results (Wilk's $\lambda = 0.3580$, $F = 11.2978$, $dF = 10,63$, $p < 0.0001$), suggesting the scapula is an excellent element for ancestry determination. In fact, cross-validated (jackknifed) classification accuracies were 88% using only 10 PCs and accounting for nearly 100% of the variation.

This research demonstrates the classificatory power of the scapula and should encourage anthropologists to investigate the geometric morphometrics of other postcranial elements and their use in the determination of ancestry.

Ancestry, Geometric Morphometrics, Discriminant Function Analysis

H34 Refining the Isotopic Fingerprint in Modern Mexican Populations: Using Strontium, Carbon, Nitrogen, and Oxygen to Determine Region of Origin for Deceased Undocumented Border Crossers

Chelsey A. Juarez, MA, 240 River Street, #1, Santa Cruz, CA 95060*

After attending this presentation, attendees will understand the incorporation of stable isotopes into human teeth and bone, the importance of sampling methodology on isotopic mapping and the varying rates of precision possible during isotopic mapping of modern populations.

This presentation will impact the forensic community and/or humanity through its pioneering application of stable isotopic analysis to deaths within a forensic context.

The goal of this presentation is to present the progress on the expansion of a mass spectrometry-based method for the identification of region of origin in modern Mexican populations through analysis of strontium, carbon, nitrogen and oxygen isotopes in human tooth enamel. Previously, this project had presented data on the success of strontium isotopes in the region of origin determination of these populations. Through the inclusion of carbon, nitrogen, and oxygen isotopes the project has expanded and refined the isotopic fingerprint of these populations.

After attending this presentation attendees will understand the incorporation of stable isotopes into human teeth and bone, the importance of sampling methodology on isotopic mapping and the varying rates of precision possible during isotopic mapping of modern populations. This

study will impact the forensic community through its pioneering application of stable isotopic analysis to deaths within a forensic context.

Background: Strontium isotope ratios and strontium concentrations collected in teeth and bones have been analyzed by archaeologists to investigate patterns of residential mobility and migration in prehistoric peoples. In this study a similar methodology is applied to forensic material to determine the region of origin for Mexican individuals that died while crossing the border into the United States. Every year approximately seven-hundred immigrants die while crossing the border between Mexico and the United States. The tragedy of this situation is compounded by low success rates in identification and repatriation of these individuals to their countries of origin. For forensic anthropologists, much of the difficulty of identifying and repatriating deceased immigrants found in border areas stems from an inability to narrow their regions of origin. Because studies estimate that approximately 86% of undocumented immigrants who cross the U.S. border are Mexican nationals this project focuses on advancing identification within that population. In order to employ identification technologies such as DNA, or dental analysis, investigators must first determine a searchable region in which to locate family, personal records and or legal documents. The aim of this project is to develop a tool for identifying region of origin in modern Mexican populations. The data discussed here are the latest stage of research on the creation of a region of origin map derived from dental enamel analysis of donated teeth from persons born in various Mexican states and regions. The map is being created from the donated teeth of Mexican-born individuals of known origin and will be used for cross-comparison with deceased border-crossers of unknown origin.

Methodology: The teeth used for this project came from clinics in Mexico and California that donated the extracted teeth of their Mexican born patients. This investigation utilized the permanent molar teeth of 50 individuals. These tooth samples retained the accompanying information on the individuals region of origin within Mexico, their age, and sex. Each tooth was washed with dilute acetic acid to ensure the removal of any depositional contamination and analyzed using TIMS and MC-ICPMS.

Results and Discussion: The goal of this project is to provide the most accurate pathway to identification possible. The initial results of this isotopic expansion are promising and build upon the previous presented research, revealing the formation of five clearly distinct separate and identifiable isotopic populations that correspond to five specific geographical regions. The presence of these new and more clearly defined ranges strongly supports previous research and brings this study one step closer to working identifications.

Isotopes, Region of Origin, Border Death

H35 Assessment of Determination of Handedness Using Standard Osteological Measurements of the Shoulder Girdle and Arm Long Bones from Individuals of Known Handedness

Marie Elaine Danforth, PhD, and Andrew R. Thompson, BA, University of Southern Mississippi, Department of Anthropology and Sociology, 118 College Drive, #5074, Hattiesburg, MS 39406*

After attending this presentation, attendees will be able to better evaluate accuracy in determination of handedness in skeletal remains using standard arm bone dimensions.

This presentation will impact the forensic community and/or humanity by presenting the first analysis of the relationship between a number of standard measurements of the upper limb and handedness in a larger sample of individuals of known handedness.

A variety of studies in forensic anthropology have attempted to assess the ability to determine handedness using skeletal markers.

Morphological indicators used have included degree of beveling of the glenoid fossa and radial tendon attachment characteristics. Other investigations have worked with long bone size. Based on Wolff's Law, they have assumed that arm bones on the side of handedness will be larger. However, most of these analyses have used only a small subset of the upper limb measurements standardly taken, and have evaluated them in prehistoric skeletal populations with the expectation that about 10% will be left-handed. While a few studies have involved individuals of known handedness, they have had serious limitations. For example, Blackburn and Knusel (2006) primarily looked at only one measurement, epicondylar breadth; Schuller-Ellis (1979) evaluated a few more measurements, but the sample size was ten. This project improves upon these investigations by analyzing all of the measurements suggested in the Standard Osteological Database (Buikstra and Ubelaker 1994) on a larger sample of individuals of known handedness.

Data for 34 individuals (26 right-handed, 8 left-handed) were taken from several sources, including various local forensic cases and the database of donated cases at the University of Tennessee. Both sexes were represented as were African, European, and Hispanic ancestries. Measurements included both length and transverse dimensions of the scapula, clavicle, humerus, ulna, and radius. As with the previous studies, it was hypothesized that dimensions would be greater on the side of handedness.

Bone length differences were addressed first since several studies have suggested they varied by handedness. The humeri were found to be longer on the side of handedness in 38% (10/26) of cases as compared to about 70% for both the radii and ulnae; the mean length differential between sides for the individual bones was 2.1 mm. When the combined radius and humerus lengths were compared bilaterally, the greater sum correlated with side of handedness in 63% (14/22) of individuals with a mean length difference of 2.9 mm. For the combined length of all arm long bones, values were 60% (12/20) and 4.1 mm, respectively.

Results of analysis of transverse measurements were of mixed success. Scapular and clavicular dimensions showed extensive bilateral variation, inaccurately predicting handedness in over half of the cases, especially left-handers. Greater epicondylar breadth correlated with handedness in 18 of 28 (64%) individuals, or just slightly better than that reported in Blackburn and Knusel's (2006) study. When differences were present in the maximum midshaft measurement of the humerus, the side of handedness was larger in 84% of individuals. The minimum diameter measurement was correct in 60%. Transverse measurements of the radius and ulna offered less promise since they were much more likely to be bilaterally symmetrical. When a consistent pattern of differences was seen (at least two of the four measurements varied), it favored the side of handedness in 50% (10/20) of cases; perhaps equally noteworthy, it favored the opposite side in 6 of 20 (30%) cases. Among all of these data, no distinctions by sex or ancestral group were seen.

Overall, use of the standard measurements is not very encouraging in determining handedness. The humeral midshaft dimensions seem to be the most accurate followed by length of the individual forearm bones. In contrast, the other measurements considered had accuracy rates barely higher than those associated with flipping a coin. It is still possible that the basic assumption is not necessarily flawed. Steele and Mays (1995) have argued that variation in bone lengths, and presumably transverse dimensions as well, are primarily related to environmental factors. Furthermore, extensive bilateral asymmetry has been found in many prehistoric populations, but results here may suggest that modern individuals are less likely to perform the strenuous activities necessary to produce size differentials similar to those seen in the past. Therefore, it is recommended that additional means beyond bone asymmetry be developed to more accurately assess handedness.

Handedness, Long Bone Measurements, Bilateral Asymmetry

H36 Bilateral Asymmetry and Handedness: Are they Really Related?

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After attending this presentation, attendees will better understand the statistical correlation between handedness and the bilateral asymmetry found in human skeletal remains.

This presentation will impact the forensic community and/or humanity by showing whether bilateral asymmetry can and should be used to determine handedness. Determining the handedness of an unknown individual would expand the biological profile. Every characteristic that strengthens the biological profile of an individual makes an impact on the forensic community.

Being able to recognize identifying characteristics from skeletal remains is essential in the practice of forensic anthropology. Any improvement in identification techniques is beneficial to those practicing in the field. Determining the handedness of an individual from their skeletal remains is a tool that can be used by the forensic scientist in helping to develop a more complete biological profile from which to identify an individual.

Bilateral asymmetry of the limbs has been used as an indicator of handedness in skeletal remains. When an individual has an arm (specifically the humerus) that is longer on the right side- it has been assumed that they were likely right handed. Another example, Kerley (1972) indicated that the bilateral asymmetry seen in clavicles could be used to determine handedness. In contrast, an individual with a longer right leg (especially the tibia) is believed to be left handed due to the use of the opposite leg as a "plant leg." While this practice of identifying handedness is widely (and loosely) used, the statistical significance of the difference has not been thoroughly examined; it has been seen as a given that the sides should differ because of difference in usage.

Numerous studies have been done that have examined the asymmetry that exists within an individual skeleton; this asymmetry has been used as an indicator of handedness. The reverse rationalization has also been given- handedness has been used to explain bilateral asymmetry. Steele and Mays (1995) examined upper limb bones within skeletons dating from the eleventh to the sixteenth century, while Èuk, Leben-Seljak, and Tefanèie (2001) noted bilateral asymmetry within a medieval sample. Steele and Mays noted distinctive asymmetry while the medieval skeletons exhibited correlations between the humerus and the opposite tibia. However, obviously, the actual handedness is unknown in these samples. Glassman and Bass (1986) recognized the lack of known handedness, and instead, looked for correlations between jugular foramen size and limb length (both which have been used as indicators of handedness) within single individuals. They did not find significant association between the jugular formation size and the limb length within single individuals. Because handedness was unknown for this sample, determining which characteristic (if either) was related to handedness was not possible.

The lack of known handedness was a definite limiter in each of the above studies. In 1980, Schuller-Elli utilized medical school cadavers with known handedness. This study supported use related differences; however, the sample only included ten pairs of arms (humerus, radius and ulna) and scapulae. The current study was an effort to correlate bilateral asymmetry with handedness by utilizing a larger sample of skeleton with known handedness.

The William M. Bass Donated Skeletal Collection housed at the University of Tennessee in Knoxville was utilized in this study. Whenever possible, a biological questionnaire is completed when an individual is donated. These include a question related to handedness. This information in conjunction with the skeletal remains presented a good opportunity to examine the actual statistical correlation between handedness and bilateral asymmetry.

For this study, the maximum length of each pair of limb bones (arms and legs) and the clavicles were measured. After examining the 105 individual donations with known (self reported) handedness; the results were not particularly supportive of practiced identifications. Those individuals reported to be right handed exhibited significant difference between the sides; they exhibited bilateral asymmetry. However, lefties showed no significant asymmetry. In addition, when the left and right handed samples were joined, it was not possible to separate them into groups of handedness. The sample was made up more heavily of individuals noted as "right handed"; therefore, there was a sampling bias. However, the ratio of the sample does mimic the ratio of handedness seen in the general population. Establishing the handedness of an unknown sample would prove very difficult unless it was a more unique sample than was available here.

Handedness, Bilateral Asymmetry, Limb Bones

H37 Correlation of Forensic Anthropologic Findings With DNA Profiles Obtained From Cold Cases

Heather Walsh-Haney, MA, and Sulekha R. Coticone, PhD*, Florida Gulf Coast University, 10501 FGCU Boulevard, Ft. Myers, FL 33965*

After attending this presentation, attendees will understand the methods of extraction of DNA from environmentally challenged samples (bones) that can be used for cold cases.

This presentation will impact the forensic community and/or humanity by providing the physical anthropologist alternate methods to detect DNA from samples commonly seen in cold cases providing rapid resolution of cases.

The identification of missing and unidentified persons in cold cases poses a number of challenges. Current Deoxyribonucleic acid (DNA) extraction methods, apart from being extremely time consuming and labor-intensive, carry additional risks of degradation and contamination. The recovery of DNA from bones presents specific difficulties in DNA purification and the amplification using polymerase chain reaction in the presence of inhibitors. Moreover, samples of DNA extracted from bones may be highly degraded and difficult to extract in sufficient quality and quantity. Associating anthropologic findings from macroscopic analyses with DNA results provide (1) for an effective method for rapid resolution of cases, and (2) a direct test of the accuracy of traditional anthropological analyses.

In the present study cold case samples (N=45) from Florida Medical Examiner Districts 4 and 20 were initially analyzed using forensic anthropologic methods: nonmetric and metric analysis of bones and teeth in order to determine the unknown decedent's biological profile, e.g., age, ancestry, sex, and stature. Age estimation was determined through macroscopic analysis of the sternal end of the right fourth rib and pubic symphyseal surfaces. Ancestry, sex, and stature were primarily determined through metric assessment (in mm.) with FORDISC 3.9. Subsequently, fibular bone was excised from each decedent using a Stryker oscillating bone saw. A new saw blade was used for each sample in order to prevent contamination. The fibular sections consisted of one (1) 2-inch by 4-inch window that was divided in half and placed into sterile test ampoules (e.g., one COVARIS and one mortar/pestle sample) following Armed Forces DNA Identification laboratory (AFDIL) protocol. When the right fibula was absent the right fibula was substituted.

For DNA extraction, a novel ultrasonic technology, the Covaris™ E200, was utilized to rapidly and effectively extract even trace amounts of DNA from human long bones. Notably, this technology not only extracts DNA but also preserves its integrity since there is minimal heating or foaming during the automated extraction process. The goal for the extraction procedure involved minimal handling of DNA after extraction to prevent contamination of the DNA obtained from other sources e.g.,

technician, anthropologist, and other cases. Human bones were processed using the Covaris™ Cryo prep unit, followed by ultrasonic treatment with the Covaris™ E200. DNA was obtained by salt extraction followed by purification with silica beads. Subsequently, the DNA was amplified using primers designed for the amelogenin locus. Both agarose and capillary electrophoresis analysis revealed DNA of high quality and quantity from control bone samples. The authors will also present data from some cold cases correlating the sex and origin based on anthropological findings vs. STR analysis. The protocol is being optimized to decrease inhibition and degradation for use with environmentally compromised samples including those human skeletal remains that have been burned, both during the post and perimortem intervals, and/or exposed to the elements years (e.g., water, sun, wind, and soil) for months to years.

Anthropologic Findings, Bones, DNA Extraction

H38 Ossification of Laryngeal Structures: As Indicators of Age

Heather M. Garvin, BA, BS, 1422 Pearce Park, Apartment # 6, Erie, PA 16502*

After attending this presentation, attendees will understand the reliability of using the fusion of the greater horns of the hyoid and ossification of the thyroid cartilage as age indicators as well as the general trends of these processes.

This presentation will impact the forensic community and/or humanity by demonstrating how radiographic examination of the laryngeal structures from a modern forensic population can provide further data regarding these aging patterns and suggests that, while general trends can be noted, determination of a narrow age range is not possible.

A detailed literature search reveals conflicting conclusions regarding the pattern of ossification of the laryngeal structures, specifically the fusion of the greater horns of the hyoid and the calcification and ossification of the thyroid cartilage. While all studies agree that the two processes occur after the age of 20, there are disputes regarding the reliability of using the patterns of fusion and ossification for age determination.

Although Forensic Anthropology is a rapidly growing field, the reliance of Medical Examiners on anthropological experts is still below par. While skeletal remains or individual body parts are likely to find their way to a Forensic Anthropologist, sending decomposed, fleshed unidentified bodies presents logistical difficulties for many offices. Experienced Forensic Anthropologists may not be available locally, and unless the Anthropologist is willing to retrieve the body from the Medical Examiner's Office, an anthropological examination is unlikely. Radiographic analyses present a compromise to the current situation. Areas known to ossify with age such as the thyroid cartilage and costal cartilages are generally extracted during routine autopsies. The process of taking radiographs of such structures and developing the film can be completed in a matter of minutes, and can be ready for examination even before the autopsy has been completed. Because these radiographic techniques do not interfere with any standard autopsy procedures, it also presents an opportunity for Forensic Anthropologists to study large modern samples. Furthermore, the legal and moral issues faced when attempting to retain bone samples for analysis, are less frequently encountered.

In this study, 106 isolated laryngeal structures removed by the Medical Examiners during autopsy were radiographically examined. Fusion of the greater horns of the hyoid and thyroid cartilage ossification patterns were noted, along with the age, sex, and ancestry of each individual. Statistical analyses were run to determine if any significant correlation existed between the fusion and ossification patterns with age. These data were also analyzed for population patterns or trends to the results of previous studies.

Results conclude that although sexually variant trends may be noted, correlating the degree of ossification to such narrow age ranges as provided by previous studies, is neither practical, nor accurate. Ossification patterns were insignificant between racial groups. Likewise, fusion of the greater horns of the hyoid was proven to be erratic and only useful when fused to conclude that an individual is a middle-aged to older adult.

Traditional studies have presented theories suggesting the hyoid fuses, and thyroid cartilage ossifies with age, and that this information may be used to facilitate age determination. However, these older studies generally establish small sample sizes. The most well known study, conducted by Cerny in 1983 used a sample of five ossified thyroid cartilages to create general trends for age groups, which forensic anthropologists still refer to today. Examining these patterns on a modern, known sample improves and may serve to disprove the reliability of such techniques. Furthermore, a closer investigation may reveal that aging is likely only one of many influences in these processes, where ossification may only be related to age at death in a merely probabilistic way, similar to the probability of undergoing a particular process or event during a particular life span. This scenario is a far cry from the narrow age ranges applied to the hyoid and thyroid cartilage from past studies.

Thyroid Cartilage, Hyoid, Ossification

H39 Age Related Changes of the Distal Humerus

Emily Jeavons, BS, Bournemouth University, School of Conservation Science, Talbot Campus, Poole, Dorset BH12 5BB, United Kingdom*

After attending this presentation, attendees will understand how the distal humerus and the supra-condylar ridges in particular, changes with age and whether sex, handedness or occupation have any effect on these changes.

This presentation will impact the forensic community and/or humanity by introducing the idea that the distal humerus undergoes distinct and recordable changes as an individual ages and suggest that these changes could be a contributor to multifactorial age at death estimation.

This study evaluates seven morphological changes, which occur at the distal humerus. It aims to discover if these changes are age-related and whether they can be used to estimate the age at death of an unknown individual.

The morphological changes studied were classified as Lateral Ridge, Lateral Enthesophytes, Double Ridge, Macro Porosity, Pinprick Porosity, Medial Ridge and Medial Enthesophytes. Lateral Ridge and Medial Ridge assess the overall appearance of the lateral and medial supracondylar ridges of the humerus respectively, Lateral Enthesophytes and Medial Enthesophytes assess the percentage coverage by enthesophytes along the lateral and medial supracondylar ridges, Macro Porosity and Pinprick Porosity assess the percentage coverage by porosity along the lateral supracondylar ridge and Double Ridge assess the presence of two ridges forming along the lateral supracondylar ridge.

A scoring system was created so that the severity of each of the seven morphological changes could be recorded, for each humeri studied. A sample of both left and right humeri belonging to individuals of known age and sex from the Christchurch Spitalfields collection was studied. All appropriate humeri from the Spitalfields collection were scored using the system developed.

The results were subjected to statistical testing and then analysed to see if any of the observed changes could be significantly related to age at death. Due to the anatomical position of the area studied, other factors, such as handedness, occupation and sex, could also contribute to the severity of any changes that occur. For this reason, comparisons were made between males and females, and left and right humeri.

Age at death showed a significant correlation with four of the observed morphological traits for females, Lateral Ridge score and Double

Ridge score for left and right humeri, and Medial Ridge score and Medial Enthesophyte score for left humeri only. For males, age at death showed a significant correlation with Medial Enthesophyte score for the left humeri only.

Male scores were significantly higher than female scores for Lateral Ridge for both left and right humeri, and Pinprick Porosity for left humeri only. Female scores for Medial Enthesophytes were significantly higher than male scores for left humeri only.

The scores from right humeri were significantly greater than the scores from left humeri for Lateral Ridge for both males and females, and for Lateral Enthesophytes for males only. The scores from left humeri were significantly greater than those from right humeri for Medial Enthesophytes for females only.

A multiple regression analysis using dummy variables was carried out. The outcome showed that age at death could not be accurately predicted using the seven morphological traits studied, but the model for females was far more accurate than the model for males. If further work could be carried out, it may be possible to produce a model that would predict age at death from the distal humerus, but only for female individuals.

Distal Humerus, Age-Related Changes, Supra-Condylar Ridge

H40 The Determination of Age Using the Acetabulum of the Os Coxa

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The goal of this presentation is to provide the audience with analyses of several features of the acetabulum of the os coxa as an indicator of age at death. Participants will be introduced to a new methodological approach using this feature, as well as a reexamination of the methods introduced by Rouge Maillert et al. (2004).

This presentation will impact the forensic community and/or humanity by providing another nonmetric approach for the determination of age at death. Revisions of previously published methods combined with employing a larger sample size and multiple ancestries permits a more comprehensive examination. The authors' method, combined with other nonmetric analyses, provides further support when making a determination of age. With the os coxa's longevity and little susceptibility to trauma, this method could be employed in a variety of contexts. Statistically and anthroposcopically, the rim follows a predictable degenerative pattern that is correlated with age and is appropriate as a new method of analysis.

Multiple regions of the os coxae have been used in studies related to aging methods. Several researchers have documented the use of the acetabulum in aging studies, but most have inadequate or inappropriate sample sizes, or they are restricted to white males. The current study considers several characters of the acetabulum on the os coxa for degenerative changes to assess the technique as an age at death estimator. Drawing on the previous work of Rouge Maillart et al. (2004), 400 modern individuals ranging from 15 to 96 years old, and of known sex and ancestry, were observed from the William Bass Skeletal Collection housed at the University of Tennessee, Knoxville, Tennessee and the Hamilton County Medical Examiners Office, Chattanooga, Tennessee. Individual os coxae were assessed for the progression of degeneration in three major areas of the acetabulum: the acetabular rim, the acetabular fossa, and the apex of the lunar surface. Each variable was subdivided into several character states following anatomical descriptions and/or previously published descriptions of degenerative change.

Results indicate that degeneration of the acetabulum occurs linearly and is positively associated with progressive age. Boxplots of the mean, standard error, and standard deviation were visually examined for a

general understanding of the significance of each variable. Spearman correlation analysis and Kruskal-Wallis (K-W) tests were performed on the dataset. Kruskal-Wallis, a nonparametric analysis of variance, has been previously demonstrated to be appropriate for ordinal data. The Kruskal-Wallis tests suggest both sex and ancestry are correlated significantly with age. Of the three acetabular variables, only rim morphology and acetabulum apex were consistently correlated and significant in the K-W tests. This is apart from the black male and female sample, both of which likely suffer from small sample sizes. White males and females showed significant correlation between age and the degenerative changes on the rim (males: $r(6) = 0.526, p < .001$; females: $r(6) = 0.573, p < .001$) and the apex (males $r(6) = 0.390, p < .001$; females: $r(6) = 0.394, p < .001$). These two traits also had significant Kruskal-Wallis tests (K-W = 161.425 and 115.280, respectively, $p < .002$).

Acetabulum, Age at Death, Os Coxa

H41 Matjes River Rockshelter: A Case of Commingled Remains

Ericka N L'Abbe, PhD, Marius Loots, BSc, and Natalie Keough, BSc, University of Pretoria, Faculty of Health Sciences, Department of Anatomy, PO Box 2034, Pretoria, 0001, South Africa*

After attending this presentation, attendees will have alternative ideas for researching forensic problems on existing skeletal collections, gain insight into one approach to sorting and documenting cases of large scale commingling, and learn about the basic demography of the Matjes River skeletal collection.

This presentation will impact the forensic community and/or humanity by providing a better understanding of sorting such remains in a forensic context. This study benefits both physical and forensic anthropologists in that it presents alternative sources for researching current problems and demonstrates what can be achieved from human remains when modern techniques, such as DNA, are not available. For local archaeologists, the results will help in understanding the human side to the cultural remains found on the site.

The sorting of commingled remains is not an uncommon practice in South Africa, where several forensic cases have been known to contain more than one person. The greatest number of skeletal remains from a single forensic case has come from the town of Duiwelskloof, in which the disarticulated bones of 11 people were packed into a grain bag and discarded in the forest. This case brought about an interest in exploring various anthropological methodologies in sorting human remains and how they could be applied in a situation where the outcome of a court case was not dependent on the result of the study.

Between 1932 and 1956, one of the largest collections of human remains was removed from the Matjes River Rockshelter, which dates from 3,000 to 10,000 BP. However, the methodologies used to excavate these skeletons were less than adequate. After removal, the bones were stored by skeletal element and hence, commingled. This afforded an opportunity to test various approaches to sort the remains into individuals and, at the same time, the demographics (sex and age) of the commingled group in question could be described.

The first phase of the study was to determine the extent of the collection, the minimum number of individuals (MNI) as well as to provide an estimation of age and sex for the remains. Each box of bones in the collection and each possible individual in a box was assigned a unique number and photographed. All bones were counted and the most common skeletal elements were selected to establish an MNI. In the skull, the most numerous were the right parietal and the left mandible with 80 and 71 unique pieces, respectively. A similar pattern was observed in the upper limbs with 115 left humeri, 95 left radii, and 119 left ulnae. No less than 50 persons were recorded from the lower limbs. Approximately, 27 females, 27 males and 17 persons of indeterminate sex were recorded. Of

these 39 were adults, 27 juveniles and 5 of indeterminate age. As skeletal elements are paired with each other, it is expected that the estimation of age and sex will change. In conclusion, it is possible to say that the Matjes River skeletal collection contains at least 100 people; future research will focus on developing techniques in which various skeletal elements can be sorted to specific individuals.

Studies on commingled skeletal collections will serve to provide a better understanding of sorting such remains in a forensic context. This study benefits both physical and forensic anthropologists in that it presents alternative sources for researching current problems and demonstrates what can be achieved from human remains when modern techniques, such as DNA, are not available. For local archaeologists, the results will help in understanding the human side to the cultural remains found on the site.

Skeletons, Research Collections, Commingled Remains

H42 Differential Wound Healing Patterns in Bone: A Case Study Involving Multiple Antemortem Injuries

Allison Bouwman, BA, Jessica Dimka, BS, Jennifer Halpain, BS, Turhon A. Murad, PhD, and Eric J. Bartelink, PhD, California State University, Chico, 400 West First Street, Department of Anthropology, Butte #311, Chico, CA 95929-0400*

After attending this presentation, attendees will gain a greater understanding of differential healing patterns of antemortem injuries, skeletal changes associated with amputation, and potential osteological changes resulting from eye implant surgery.

This presentation will impact the forensic community and/or humanity by enhancing the understanding of bone remodeling processes in antemortem injuries when the mechanism and date of injury are known.

In August 2001, human remains were discovered along a roadside in northern California and were submitted to the Human Identification Laboratory at California State University, Chico for analysis. The remains were subsequently identified and later donated by the next-of-kin for educational purposes. The biological profile indicated that the remains belonged to an adult male, between 40 and 50 years of age, with an estimated stature between 6'2" and 6'4". Although Fordisc 3.0 classified the decedent as Hispanic male (posterior probability = .434, typicality = .625), the cranium could not be excluded from several of the other reference samples in the databank. Nonmetric analysis of the skull further suggested a combination of European and Asian traits. The decedent was identified as an adult male, 46 years of age, with a reported stature of 6'2". Although the missing persons record reported the decedent as "White", the individual is believed to have been of mixed ancestry.

Prior to his death, the decedent sustained numerous injuries resulting from a motorcycle accident, including fractures of the thorax, the vertebral column, the distal right radius (Colles's fracture), the proximal right humeral head, the left and right innominates, the right proximal foot phalanges of digits I and III, the left femur, and the left tibia and fibula. The left femur sustained a massive comminuted fracture and was repaired with an internal fixation device, which is enveloped by hypertrophic bone growth along the lateral aspect of the diaphysis. The injury to the left tibia and fibula resulted in a "below-the-knee" amputation. These elements are represented by their proximal ends, and both show enclosed medullary shafts at the amputation site. The decedent also had an implanted left eye. The inferior border of the left orbit shows significant evidence of bony remodeling, with perforations that interconnect the orbit with the nasal aperture and maxillary sinus. The orbital plate and inferior orbital margin are also depressed relative to the contralateral side, and show marked asymmetry.

Although these injuries resulted from a single traumatic event, there are substantial differences in the degree of wound healing between elements. Injuries of the ribs, phalanges, radius, innominates, and

amputation site all appear to be well healed. However, the fracture of the left femur shows active signs of hypertrophic bone formation, indicating an earlier stage of healing compared with the other injuries.

This presentation focuses on differential processes of healing and bone remodeling associated with antemortem trauma. The injuries in this case study were sustained in the same event but show varying stages of healing. This study highlights that a greater understanding of the timing and pattern of antemortem injuries can be especially useful for the purposes of identification.

Amputation, Antemortem Trauma, Orthopedic Devices

H43 Hyoid Fusion and the Relationship With Fracture: Forensic Anthropological Implications

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After attending this presentation, attendees will understand that fracture of the hyoid bone is dependent on the type of traumatic force applied to it. The research presented here was tested on a sample of hyoid bones from the McCormick Collection curated at the University of Tennessee. Fracture was statistically compared with fusion of greater horns to the body and results indicate that the hyoid is a diagnostic element for reconstructing various kinds of trauma. However, the relationship between fusion and fracture is statistically insignificant in this sample.

This presentation will impact the forensic community and/or humanity by stressing that hyoid bones should be carefully examined in any instance of suspected neck trauma and that fusion of the great horns to the body is not a statistically significant indicator of the presence or absence of fracture.

Although hyoid fractures only comprise a mere 0.002% of all bony fractures (Bagnoli *et al.* 1988), their importance in forensic contexts cannot be overlooked. Oftentimes such fractures are indicative of direct trauma to the neck resulting from manual strangulation, ligature strangulation, or hanging (Ubelaker 1992; Pollanen and Chiasson 1996; Pollanen and Ubelaker 1997). While some hyoids may be more likely to fracture than others, numerous factors influence the likelihood of such occurrences (Pollanen and Chiasson 1996). Such variables include the magnitude and position of applied force, rigidity of the bone itself, and shape (Pollanen and Chiasson 1996).

The union of the parts of the hyoid is correlated to the age and sex of the individual to which they belong. Over time, the greater cornua fuse to the hyoid body and “essentially become one bone” (Guilbeau 1992). In order to determine the occurrence of hyoid fusion, O’Halloran and Lundy (1987) examined hyoid bones of 300 autopsy case from Oregon and California. According to their findings, some fusion was observed in the third decade and increased with age, resulting in “70% of the joints in men and 60% of the joints in women fused by age 60” (O’Halloran and Lundy 1987). Unlike the previous study, Miller and coworker’s examination 188 male and 127 female hyoid bones found “little evidence for a sex difference in the age at which bilateral fusion occurs” (Miller *et al.* 1998). Furthermore, the author’s argue that numerous elderly individuals present hyoids with either unilateral or bilateral non-fusion.

In theory, a hyoid with bilateral fusion would be more likely to fail than a hyoid with unfused cornua. The literature reveals variable frequency rates of fracture dependent on the type of trauma inflicted and the degree to which the hyoid bone is ossified. Ubelaker’s (1992) review of hyoid bone fracture delineated three types of trauma that characteristically result in bone failure. He writes that hyoid fractures resultant of hanging have an incidence that ranges from 6 to 20%. Luke *et al.* (1985) note that the variable location of ligature placement, along with other mechanical factors such as drop height, account for the low

frequency of hyoid fracture during hanging. The frequency of fracture due to ligature strangulation is substantially higher with rates ranging from 13 to 54% (Ubelaker 1992). Manual strangulation rates appear to be the highest with frequencies ranging from 17 to 71% (Ubelaker 1992). Furthermore, in an attempt to qualify prior reports, Pollanen and Chiasson (1996) evaluated the radiographs of twenty hyoid bones of victims of manual strangulation. Of the twenty hyoids utilized in their study, ten exhibited fracture and ten displayed no sign of fracture. Their data illustrated that 70% of fractured hyoids were fused, whereas 30% of unfractured hyoids were fused. Pollanen and Chiasson assert “this data indicates that age-dependant fusion of the hyoid bone increases the probability of hyoid bone fracture.”

In order to evaluate the relationship between hyoid fusion and its propensity for fracture, hyoid bones from the McCormick Collection curated by the Department of Anthropology at the University of Tennessee were examined. Condensed case reports ranging from 1986 to 1996 were evaluated to determine instances of fatal neck trauma including manual strangulation, ligature strangulation, and hanging. Hyoids for which all data (sex, age-at-death, and manner-of-death) were available were exclusively examined (n=28). Mean age-at-death of the sample was 37.28 years and 32.1% (n=9) of hyoids in the sample were fractured. Interestingly, 100% (n=4) of manual strangulation cases were fractured while 20.8% (n=5) of hanging cases were fractured. Although the sample size is small, these results produce similar frequencies to those of Luke and colleagues (1985) and Ubelaker (1992).

Non-parametric chi-square analyses tested the relationship between the state of fusion and fracture and produced statistically insignificant results (P=.600). Such results do not indicate a significant relationship between fusion of the greater cornua and fracture. These findings suggest that forensic anthropologists should carefully examine all suspect cases of fatal neck trauma and that predictable patterns between hyoid fusion and fracture are elusive as evidenced by this sample.

Hyoid Bone, Neck Trauma, Forensic Anthropology

H44 The Potential Diagnostic Value of Scanning Electron Microscopy in the Differential Diagnosis of Bone Lesions: A Pilot Study

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The goal of this presentation is to illustrate the potential diagnostic value of scanning electron microscopy in the differential diagnosis of bone lesions and the anthropological analysis of human remains in forensic settings.

This presentation will impact the forensic community and/or humanity by presenting microscopic skeletal lesion margin characteristics for three different types of neoplastic diseases and by introducing new terminology to describe the microscopic features observed in the SEM images.

The goal of this presentation is to illustrate the potential diagnostic value of scanning electron microscopy (SEM) in the differential diagnosis of bone lesions and the anthropological analysis of human remains in forensic settings.

The study of pathological conditions in skeletal samples is restricted to bony manifestations of disease; the differential diagnosis of bone lesions identifies certain pathological conditions as likely candidates, although none can be eliminated based on the standards currently available. While paleopathological analyses have the liberty to stop at this point, forensic investigations require more specificity, particularly in cases of unidentified individuals represented solely by skeletal remains.

Previous anthropological studies have demonstrated the necessity of multidisciplinary approaches for the most accurate study of pathological conditions in archaeological specimens. Current non-destructive methods

for diagnosing disease from the skeleton include gross morphological examination and radiography of the lesions. This pilot study represents the initial phase of a research project that will test whether SEM contributes any additional diagnostic information to the identification of pathological conditions by examining the margins of lesions resulting from various disease processes in a modern documented sample. The hypothesis to be tested is as follows: SEM will illustrate differences in the margin morphology of bone lesions. The null hypothesis is that there is no difference in the data provided by gross morphology, radiography, and SEM. The alternative hypothesis is that significant differences exist among the morphological data provided by gross examination, radiography, and scanning electron microscopy. The criterion for determining if a difference exists is whether new terminology is needed to describe the microscopic morphological features observed in the SEM images. If the current descriptors are inadequate, then SEM is inherently contributing new information.

Three specimens with clinically diagnosed cancers (metastatic breast cancer, diffuse histiocytic lymphoma, and multiple myeloma) were drawn from the Maxwell Museum of Anthropology's documented skeletal collection. Gross observation, radiography, and SEM were used to examine bones with lesions. The skeletal elements were radiographed using a Hewlett Packard 43805N Faxitron X-ray machine, and the backscattered electron detector was utilized to gather topographic information from the bones in the low vacuum mode of the JEOL JSM-5800LV scanning electron microscope (equipped with Oxford Isis 300 digital image capturing). To test whether scanning electron microscopy contributed information not available through current methods, all three images (digital photographs of gross morphology, radiographs, and SEM images) for each specimen were visually assessed and a written description of the observed morphology was generated.

The preliminary results of this research indicate that SEM—in conjunction with radiography and gross morphological examination—is a valuable tool for the recognition of neoplastic disease from skeletal remains in modern populations and forensic settings. Based on the specimens examined, scanning electron microscopy contributes additional data not previously available using traditional techniques; the microscopic features observed in the SEM images were not adequately described by standard gross morphological or radiographic terminology. Accordingly, feedback from the forensic community will be sought to refine new terminology that accurately and meaningfully captures the variation observed. However, a larger sample size (encompassing other pathological conditions) is necessary to strengthen this conclusion and determine whether SEM contributes diagnostic robusticity to the differential diagnosis of bone lesions in forensic anthropological contexts, as well as paleopathological and bioarchaeological research. Such diagnostic specificity would greatly benefit forensic anthropological investigations by contributing to the determination of cause and manner of death and/or the identification of unknown individuals.

Skeletal Lesions, Osteology, Scanning Electron Microscopy

H45 Evaluation of the Mandibular Angle as an Indicator of Sex

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The goal of this presentation is to demonstrate the utility of the mandibular angle as an indicator of sex in unknown human skeletal remains.

This presentation will impact the forensic community and/or humanity by demonstrating that the mandibular angle is a poor indicator for determining biological sex.

Determining the biological sex of unidentified human skeletal remains is one of the most crucial components of the biological profile created by the osteologist as ancestral designations and age assessments are known to be affected by this factor. The accuracy of the sex determination is in turn often dependent on which skeletal elements are present for analysis. Ideally, the *os coxae* are employed because their morphology is particularly indicative of an individual's sex. Unfortunately, the morphological features that are most useful for sex estimation are often destroyed by taphonomic forces such as erosion or scavenger activity. Additionally, the preferred elements for the estimation of sex are not always present for analysis due to their initial absence thus forcing the anthropologist to examine other elements to determine sex. The cranium also presents characteristics that are useful for sex assessment; however, these features may be damaged or lost as well. The mandible is one of the densest bones in the skeleton and is more likely to survive taphonomic forces in an archaeological or forensic context. Although, sex estimates using the mandible are generally not as accurate as other elements it is at times the only useful or available element present for analysis.

It is generally accepted and taught in classrooms that the mandibular angle is an indicator of sex, where males have a squared and more vertical angle, while females tend to have a more obtuse angle. The mandibular angle is a standard osteometric measurement taken with a mandibulometer. Standard osteometric manuals describe the measurement as the angle made by the inferior border of the body and the posterior border of the ramus. Few texts give more than a general statement about the mandibular angle, usually suggesting that it is a non-metric indicator of sex. The document that provides a numeric threshold reference is an obscure older European text that suggests that an angle > 125 degrees is female and an angle < 125 degrees is a male (Acsadi and Nemeskeri 1970).

This study examines the validity of the mandibular angle measurement as an indicator of sex using data derived from the Terry Collection and modern forensic cases. The Terry collection sample consists of 315 individuals (166 females, 149 males) of African and European ancestry. The forensic sample will be of a comparable size and composition derived from cases processed by the C.A. Pound Human Identification laboratory at the University of Florida.

Statistical analysis is performed on the sample as a whole, by ancestry group, and by sample. The percentages of individuals falling above and below the 125 degree threshold are calculated. Additionally, ANCOVA is used to determine if sex, ancestry, age, or sample have an effect on mandibular angle measurements. Preliminary results indicate that there is a great deal of overlap in mandibular angle measurements between males and females. With ancestry groups combined the 125 degree threshold misclassified 55 % of males, and 37 % of females. When controlling for ancestry the threshold misclassified 63 % of European males and 33 % of European females. The threshold misclassified 47 % of African males and 41 % of African females. The ANCOVA results indicate that ancestry has a significant relationship with mandibular angle variance; however, age and sex do not. The above results suggest that the mandibular angle is a poor lone indicator of sex and that the 125 degree threshold is not a statistically significant boundary between males and females in the samples. When attempting to determine the sex of an individual it is necessary to use as many indicators as possible, although the mandibular angle is a poor indicator of sex this study did not investigate its usefulness for sex estimation with other traits. Additionally, the results indicate that population differences exist and require further exploration along with other indicators to determine the relationship between sex and ancestry.

Mandibular Angle, Sex Determination, Forensic Anthropology

H46 Test of a Method Regarding Sex Indication of the Human Hyoid Body

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After attending this presentation, attendees will become familiar with the three measurements of the human hyoid (out of 16 possible measurements) that have been used repeatedly to demonstrate differences between the sexes. Also, this presentation will evaluate the strengths and weaknesses of taking measurements of the hyoid from radiographs (or photographs) as opposed to measuring actual bones. Results of two studies will be discussed and compared.

This presentation will impact the forensic community and/or humanity through the value of the potential for using the hyoid as a reliable sex indicator.

For forensic anthropologists, one of the smallest bones in the human body may hold information that can identify an unknown victim. A discriminant function that correctly identifies the sex of 76% or more of human hyoids may aid in the sexual identification of an unknown person (especially when other bones are not available). The purpose of this project is to test the discriminant function method for indicating sex of human hyoids as outlined by Reesink et al. (1999). Reesink et al.'s function is based on three measurements taken from radiographs of the hyoid bone: the maximal medial height of the corpus (MMH), the anterior posterior thickness of the corpus (ATP), and the maximal transverse diameter of the corpus (MTD). With that method, Reesink et al. (1999) correctly identified sex 76% of the time. The current study repeats the research by Reesink et al. (1999), but instead of using radiographs, measurements were taken from actual donated hyoids curated at the Forensic Anthropology and Computer Enhancement Services (FACES) laboratory at Louisiana State University. The measurements used in the current study were interpreted as being the height of the body, the thickness of the body, and the width of the body (see also Devlin's hyoid body measurements pp. 95-97). The FACES lab collection consists of 198 total hyoids of which 107 are males, 27 are females, and 64 are of unknown sex. All three measurements must be present to correctly use the discriminant function, and 55 males and 20 females in the FACES lab collection met these requirements.

Preliminary results of the current study suggest that all three measurements of the hyoid show statistically significant differences between males and females at $\alpha = 0.001$. This finding is supported by Reesink et al. (1999 p. 358) and Devlin (2002). Therefore, all three studies reflect that size differences exist between the hyoid bodies of males and females. In fact, in her 2002 dissertation, Devlin states "Males exhibit taller, wider, and thicker hyoid bodies in comparison to females" (p. 148).

Reesink et al.'s (1999) results from their discriminant function suggest that male values will be less than zero while female values will be greater than zero. In contrast, preliminary results of the current study where the actual bones were measured suggest that while there is a significant difference ($\alpha = .05$) between the male and female results, as derived from the discriminant function, both female and male results are negative. Specifically, the mean for all discriminant function results is -2.1783 for females and -1.2091 for males, respectively. Possible explanations for these differences in results for the two studies may include interpretation of the exact location of measurements taken (especially the ATP) and also the disparities that might arise from taking measurements from radiographs as opposed to actual bones. Future studies with larger collections could help address these concerns.

References:

- ¹ Reesink, E.M., A.A.H Van Immerseel, R. Brand, and T.J.D. Brintjes, (1999) Sexual Dimorphism of the Hyoid Bone? *International Journal of Osteoarchaeology*, 9: 357-360.
- ² Devlin, Joanne Lorraine, (2002) Morphological Considerations of the Human Hyoid Bone. *Dissertation, University of Tennessee, Knoxville.*

Human Hyoid, Discriminant Function, Sexual Dimorphism

H47 Efficient Processing of Human Remains Using Dermestid Beetles

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After attending this presentation, attendees will understand the behavior and ecology of dermestid beetles in a captive, laboratory environment will be understood such that they can be used to efficiently and effectively process human remains in a timely fashion.

This presentation will impact the forensic community and/or humanity by demonstrating the advantages of using dermestid beetles in the processing of human remains found in forensic cases and by describing new methods to efficiently and effectively use and maintain a dermestid colony.

Beetles of the family Dermestidae (Order Coleoptera) are known to feed and breed on animal proteins. Places that process animal products, for example tanneries, are therefore vulnerable to infestation by dermestids. In nature, dermestid beetles are commonly found on decomposing remains in the late stages of decay – long after such species as blowflies (Family Calliphoridae) have left. The animal proteins present in raw hides and skins are suitable habitat for larval development and a single female adult dermestid can lay hundreds of eggs. The eggs hatch after about a week into larvae that undergo several molts (instars), pupate and emerge as adults. It is the larval stages that feed on the animal material; therefore, in the case of the processing of human remains, it is the larvae that clean the skeleton. The entire cycle from egg to adult varies widely depending on temperature and humidity. Increased temperature and humidity typically speed development whereas a decrease in these factors slows it. In addition to temperature and humidity, it is important to understand that remains in nature do not undergo the same succession of insect colonization as those that are processed in a laboratory environment. An argument often made against using beetles of the genus *Dermestes* (literally "skin-eaters") to clean human remains is the time it takes for the beetles to complete the job (Byers, 2000), but with a good understanding of the ecology and behavior of the beetles, the rate at which a specimen can be cleaned can be controlled. Procedures for preparing a specimen for placement into a beetle colony describe defleshing, removing the eyes, tongue and brain, and drying. All of these ideas are predicated on the behavior of beetles in nature and each of these processes adds time in addition to the time the remains are in the colony itself. Other techniques, such as boiling, have been used in cases where the time required for beetles has been thought to be unavailable. However, these techniques pose risks to the bone, such as cracking or demineralizing, that dermestids do not. It is for this reason that the Physical Anthropology Human Identification Laboratory (PAHIL) at California State University at Chico prioritizes the use of dermestids in the processing of human remains. Such a colony has been maintained successfully for many years. A recent time-sensitive case of homicide at PAHIL which was received and completely processed from May 23 to June 6, 2006 demonstrates that, in fact, a dermestid colony can completely clean a skeleton in far less time than the literature suggests. The initial preparatory steps and maintenance of the colony used in this case in order to maximize processing efficiency and minimize the risk to the colony will be discussed. Photographs will be presented that document the daily progress of the colony and the

conditions under which it was kept. Close-up photographs of bone injury will be used to demonstrate the high quality of work that can be produced by dermestid beetles.

Reference:

¹ Byers, Steven N. *Introduction to Forensic Anthropology: a textbook*. Allyn & Bacon, Boston, MA. 2002.

Dermestid, Skeleton, Processing

H48 Bodies and Body Parts: When and How to Record Them During the Excavation of Mass Graves

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The goal of this presentation is to highlight the pitfalls that accompany defining differences between a “Body” and “Body Part” or “Body Portion” within a mass grave context and propose a standard method of recording such remains.

This presentation will impact the forensic community and/or humanity by demonstrating how consistency in defining and recording human remains from a mass grave context is important not only within a single grave, but between graves and over the course of the entire investigation. Inconsistent definitions and recording during excavation will lead to problems during mortuary examination. Mission planners should carefully consider their systems of recording prior to any operational activity.

Human remains within a mass grave context, especially secondary depositions, are regularly recovered in a disarticulated state. Care in exposing and removal of remains from a grave by an observant excavator, knowledgeable in human skeletal anatomy, is one of the most important steps in limiting (and hopefully eliminating) further disarticulation. Another important step, though often disregarded, is the consistent classifying and subsequent recording of disarticulated remains. Inconsistencies in defining incomplete portions of body could have an adverse effect on mortuary operations.

When dealing with large numbers of remains the order of autopsy typically takes into consideration the types of remains to be examined. Complete bodies are regularly processed first while incomplete bodies are examined later with an eye towards reassociation of disarticulated body portions. With hundreds (or thousands) of remains waiting to be processed, a decision may be made to bypass or delay examination of disarticulated body parts in an effort to streamline autopsy time, money, and energy, or to produce more identifications in the beginning while allowing reassociation activities to take a back seat. While not all mortuaries may operate in this manner, most will use the recovery/evidence log to set the basic order of remains examination. The classification of remains at the time of recovery may thus dictate the order of mortuary examination. Consistency in the classification of recovered remains therefore becomes an important issue.

In addition, consistent classification of remains is necessary to assist with reassociation of disarticulated remains. When dealing with hundreds to thousands of remains an ordered method of categorizing them is needed to ensure that an organized approach to reassociation is maintained. Methods such as spatial analysis of recovery location data, which relies on database queries, would be limited when recovered remains are recorded inconsistently.

While classifying and recording of recovered remains may seem straightforward, the fact is, defining what constitutes a body as opposed to a portion of body is problematic. Recovered remains are regularly classified as a “Body” or “Body Part” (sometimes with additions of “General Bone/General Body Part” to identify single disarticulated bones). Unfortunately there appears to be no agreed upon classification

system regarding what constitutes a “Body” as opposed to a “Body Part.” If a complete body is to be classified and then recorded in the evidence log as a “Body,” what do you classify a body missing an arm? Should it still be recorded as a “Body”? What if it is missing two arms, its head, and a portion of its upper torso? As a body becomes more disarticulated, at what point should the terminology be changed from “Body” to “Body Part”? It is often left up to the individual doing the recovery, guided by past experience and loose, sometimes changing definitions, which decides how the set of remains they are exposing are classified. What might constitute a “Body” for one recovery team member may be a “Body Part” to another.

Complicating the discrepancies between individuals defining the remains is the timeframe over which large investigations take place. ICTY-type post-conflict missions regularly rotate personnel during a single season, excavate several graves during that season, and continue performing in this manner for several years. Inconsistent recording between individuals, different teams working different sites, and over several months/years accumulate causing large discrepancies within the reporting.

This presentation will introduce a comprehensive classification system for use during recovery operations. While this system may not fit all mission situations, it is presented as an example of such a system mission planners should be considering prior to the start of an investigation.

Consistent classification of remains over the entire length of an investigation, especially if such investigations will take months or years to complete, is essential. Mission planners should seriously consider the methods that they will be employing in the mortuary and how recovery classifications can affect their plan. Integrating a consistent recovery classification system with mortuary operations will help to more accurately organize examination schedules (and thus streamline autopsy time, cost, and energy) and maximize available recovery observations and data for mortuary analysis.

Mass Grave, Defining Remains, Forensic Archaeology

H49 Putting It All Together: Recovery, Assembly, and Analysis of Multiple Body Parts

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The goal of this presentation is to presents a unique example of human butchering. The attendees will learn some protocol adaptations that were necessary for recovery and assembly of 57 separate parts. Attendees will see how professionals in anthropology, pathology, search and rescue, and law enforcement worked together as a team.

This presentation will impact the forensic community and/or humanity presenting a unique example of human butchering. It will also inject some effective ways to recover, process, and analyze multiple widely-scattered bones and body parts. These methods may be used in any case where recovery and identification of large numbers of disrupted human remains is problematic.

This case report presents a unique example of human butchering and explains to attendees some protocol adaptations necessary for recovery and assembly of 57 separate parts. It highlights a successful outcome resulting from teamwork between anthropology, pathology, search teams, and law enforcement officers.

A young female victim was beaten to death and her body cut to pieces inside the bedroom of her boyfriend's mobile home. The dissected tissues were then taken to two different and widely separated rural locations where some were randomly scattered and others were hidden. A chance discovery shortly after the crime allowed investigators to recover a significant amount of material from one site on the first day. The suspect directed investigators to a second site two days later.

Because many of the dissected parts involved bare bone fragments, a forensic anthropologist was called to both scenes to assist in the recovery and identification of the scattered tissues. A field inventory of identified pieces assisted in the overall scope of the investigation, and almost complete recovery of the victim. At one site, many of the pieces had simply been tucked under branches and logs, but others had been covered with leaves, stones, and loose dirt. At the other site, it appeared as if the suspect had stood at the edge of a rural road and thrown individual pieces into a ravine. The pattern of dissection and concealment reflected the suspect's previous history of illegal killing and butchering of white tail deer. For example, the viscera were removed *en bloc* and covered with a slab of limestone. Muscles and skin were cut cleanly from the extremities and then the underlying bone was serially sectioned. The flesh over the abdomen was removed as if it were a cut of brisket, before a distinctive tattoo was cut off and hidden in a different location.

Although there was only one victim, the scene recovery protocol was typical of one that would be employed in a mass fatality incident. The initial recovery scene covered approximately 5 acres and included dense woods, overgrown meadows, a fire pit, a railroad track and tunnel. (The suspect initially told investigators that he had stood over the tunnel and tossed body parts onto numerous moving trains, so trains up and down the East Coast had to be detained and searched). The second scene was several miles from the first, and included a steep bank along a winding rural road. At both scenes, individual numbers were assigned to each specimen and the location of each one documented with the "total station" mapping system. The initial numbering system was maintained throughout the investigation by the use of indelible markers, strips of plastic, and digital photography.

At autopsy, as the medical examiner described each individual piece of bone and tissue, the anthropologist assembled the body. This had to be done in layers with the skeleton assembled first, and then sections of soft tissue matched by muscle groups and cut-marks. The posterior side of the body was re-assembled and documented first. Then the pieces of flesh were removed, each bone and bone fragment turned over, and then the anterior half of the body was reassembled and documented. The left breast of the victim was the only body part not recovered.

Human Butchering, Crime Scene, Teamwork

H50 Percentage of Body Recovered and its Effect on Identification Rates and Cause/Manner of Death Determination

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After attending this presentation, attendees will better understand the relationship between the percentage of remains recovered and the ability of investigators to identify the remains and determine cause and manner of death.

This presentation will impact the forensic community and/or humanity by describing and quantifying previously unreported correlations between variables of interest to investigators and providing data for comparing identification rates in individual case work and mass death scenarios.

After attending this presentation, attendees will better understand the relationship between the percentage of remains recovered and the ability of investigators to identify the remains and determine cause and manner of death. This presentation will impact the forensic community by describing and quantifying previously unreported correlations between

variables of interest to investigators and providing data for comparing identification and ruling rates in individual case work and mass death scenarios.

Forensic anthropologists frequently encounter cases in which only partial or fragmentary remains are recovered. Intuitively, investigators would predict that the greater the proportion of a decedent's body that is recovered, the greater the probability that the individual will be positively identified and that the cause and manner of death can be determined. This study reports how the percentage of remains recovered affects rates of positive identification and cause and manner of death determination.

This study examined a total of 773 cases involving decomposed and skeletal remains analyzed by forensic anthropologists at the New Mexico Office of the Medical Investigator (OMI) from 1974 to 2006. All individuals were initially unidentified. The percentage of remains recovered was scored as follows: complete; 76 to 99% present; 51 to 75% present; 26 to 50% present; < 25% present; or represented by a single skeletal element. The presence or absence of the skull (complete or partial) was also noted. The cause, manner, and identification status of each case was recorded.

Results indicate significant correlations between the percentage of the body recovered and the rate of positive identification. The ID rate for all cases (n=773) was 77%. ID rates were highest (89%) when complete bodies were recovered (n=221), 81% when 50% or more of the body was found (n=483), but only 56% were identified when less than 50% of the remains were present (n=193). In cases where no portion of the skull was recovered (n=66), the ID rate was 61%. It is interesting to note that the introduction of DNA testing to establish ID (circa 1996) had little effect on ID rates. ID rates for all cases pre-1996 (n=520) was 76%, while 79% of the 252 post-1996 cases were positively identified.

Similar patterns were seen in the relationship between the body percent recovered and cause/manner determination. In the total sample, the cause of death could be determined in 66% of cases, while the manner was determined in 62% of all cases. Rates were again highest in complete bodies (83% cause, 79% manner). When more than 50% of the body was recovered, rates were 71% and 68% for cause and manner, respectively. Rates dropped to 40% for both cause and manner when less than half of the body was recovered, as well as when no skull was present.

These findings were compared to data drawn from typical autopsy and death investigation cases (approx. 4,100 – 5,000 cases per year) from the New Mexico medical examiner's office. The office maintains a positive identification rate of 94 to 96%. Cause of death is determined in 98.5 to 99% of all cases, while manner is ruled 96 to 98% of all deaths investigated. Manner of death distributions were dramatically different between typical autopsy cases and the anthropology consult cases. For example, homicides account for 4% of typical cases but 27% of anthropology cases.

The results of this study were also compared to prior published reports on anthropological consult cases. Identification rates for skeletal remains in the current study were significantly higher than those reported by Marks (W.M. Bass and the Development of Forensic Anthropology in Tennessee. *JFS* 40(5): 741-750, 1995) for US anthropologists (25 – 30%) and William Bass (50%). Cases in this study had higher percentages of remains recovered and greater evidence of trauma than those reported in a summary of FBI consults from 1962 to 1994 (Grisbaum and Ubelaker, *Smithsonian Contributions to Anthropology* #45, 2001).

These findings are of interest to anthropologists working on individual casework, as well as those tasked with recovery and identification in mass death scenarios. The results also argue for the participation of anthropologists in body recovery whenever necessary to maximize recovery rates.

Forensic Anthropology, Positive Identification, Cause and Manner of Death

H51 The Fourth Era of Forensic Anthropology: Examining the Future of the Discipline

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After attending this presentation, attendees will learn about trends in training, education, research, and employment that are creating the future of forensic anthropology as a broad-based scientific discipline.

Forensic anthropology is experiencing new trends in training, education, research, and employment that are impacting its future. The impact of these changes will impact how other forensic disciplines think of forensic anthropology and its interactions with forensic anthropologists.

As a scientific discipline, forensic anthropology is relatively new. Stewart (1979) and Thompson (1982) have both recognized three eras in the development of forensic anthropology. In the period before World War II, although physical anthropologists consulted occasionally on forensic cases, there was no formal instruction, little published research, and scant attention by the medicolegal community. From the 1940s to the early 1970s, forensic anthropology garnered increased attention by the military (for war dead identification), other government agencies, and medicolegal investigative departments. The field professionalized in the 1970s with the establishment of the physical anthropology section within the AAFS and the creation of the ABFA. This third period was also characterized by an increase in the number of AAFS section members, research and publications, training programs, employment, and acceptance by the forensic community.

A fourth era of forensic anthropology has recently emerged. Several trends characterize the era. Grounded in skeletal biology and anatomy, the new forensic anthropology employs a broad knowledge of anthropology,

human variation, and human biology in solving forensic questions. Forensic science laboratories, crime laboratories, and medical examiner offices employ forensic anthropologists to do more than traditional forensic anthropology- laboratory management, crime scene documentation, missing persons administration, quality assurance, and forensic project management are now routinely conducted by forensic anthropologists. Forensic anthropologists are now asked to serve as forensic managers to solve large-scale human identification problems in cases of disasters, mass graves, human rights, and missing persons. Employment of forensic anthropologists with MA/MS degrees in non-academic/applied positions has increased over the past decade, a trend that speaks to the potential of forensic anthropology outside its traditional roles.

These trends in the field lead to several questions:

- Is a new definition of the field required?
- Are students receiving the training necessary to succeed in these new areas?
- Is the field prepared to handle these new challenges?
- What trends in biological science, law, forensic science, and culture will impact forensic anthropology?
- What legal decisions and ethical trends will impact the field?

By looking at trends in research, the evolution of training programs, the broad-ranging employment of forensic anthropologists, and the application of the science to solve complex human problems, this symposium examines this new era in forensic anthropology. Among the topics to be discussed are:

- Future of education and training
- Future of trauma analysis
- Future of assessing ancestry
- Considerations for ethical standards in forensic anthropology
- Forensic anthropology and meeting evidentiary/legal demands
- Management of forensic laboratories and projects
- Changing role of forensic anthropology in medical examiner/coroner setting
- Future of human rights work and humanitarian identifications
- Future of employment

The session will conclude with a discussion among participants and questions from the audience.

Future of education and training: The profession of forensic anthropology requires advanced graduate training within physical anthropology, especially human skeletal biology, and closely related fields such as human biology/anatomy and archaeology. Therefore, the academic programs and faculty providing the required graduate training share a profound responsibility as gatekeepers to the profession. Faculty at institutions offering degree programs that seek to prepare these future forensic anthropologists must provide the educational framework that defines the field, while at the same time the evolving roles of practicing forensic anthropologists must constantly re-define academic programs. This symbiosis revolves around twin missions: The education and training of the next cohort of traditional academic anthropologists; and the training of practicing forensic anthropologists with specialized knowledge and expertise that lies beyond traditional physical anthropology.

The 1970s and early 1980s marked the establishment of the first graduate programs that implemented specialized curricula to prepare students for careers in forensic anthropology. The first graduate programs specializing in forensic anthropology during this "establishment phase" were those at Arizona, Florida, New Mexico, South Carolina and Tennessee.

Our "Fourth Era" of forensic anthropology can be witnessed as the "expansion phase", marked by an explosion in student interest nurtured by an exponential growth in media attention. This resulted in an increase in the number of universities teaching undergraduate courses on the topic, and the development of several new graduate programs specializing in forensic anthropology, including Michigan State, Mercyhurst, UC-Santa Cruz, CSU-Chico, U-Indianapolis, and SUNY Binghamton.

In the past, academic training in forensic anthropology has been conducted exclusively within a physical anthropology curriculum, focusing mainly on human osteology and skeletal biology. In fact, many members of the AAFS Physical Anthropology section graduated from departments that did not provide specialized curricula on topics in forensic anthropology. However, the increasing breadth and scope of the field, including issues of human identification, skeletal trauma, estimating postmortem interval, taphonomic modification of bone, war crimes and mass disaster investigations have lead to widening roles for forensic anthropologists. Do these ever-widening roles require specialized, interdisciplinary skills not offered by traditional academic-based anthropologists?

As the "Fourth Era" of forensic anthropology begins, a critical assessment must be undertaken to determine whether educational programs are keeping pace with recent trends and are progressing in ways that best serve the needs of the discipline. It is time to closely examine the required courses in the academic curriculum producing forensic anthropologists. Any consideration of the future of education and training in forensic anthropology must begin with a consideration of the future of the field itself. Originally defined as a laboratory-based discipline in which physical anthropologists are occasionally enlisted by law enforcement, it is not surprising then that, until the last ten years, only a handful of individuals worked full-time professionally as forensic anthropologists. Recently, an increasing number of non-academic jobs with forensic anthropology in the title or in the job description have appeared. This has occurred primarily because: 1) medical examiners now well-realize that forensic anthropologists have skills at the crime scene and at autopsy that provide valuable assistance to the multidisciplinary attempts at identification, determining cause and manner of death, and estimation of the postmortem interval, and 2) forensic anthropologists are indispensable members of both overseas human rights organizations and both private and governmental-directed disaster assistance teams.

It is clear that in the Fourth Era, forensic anthropology has been redefined as a robust and unique scientific field that requires specialized training. This requires new discussions related to educational philosophy, as well as future goals and standards for the profession. What are the essential components in the graduate education and training of a forensic anthropologist in this new era? Essential components to be discussed include: 1. Experience with large samples of human skeletons to provide the most basic and crucial understanding in human skeletal variation; 2. Specialized coursework on topics within forensic anthropology; and 3. Hands-on experience with real forensic cases.

It is also necessary to examine whether graduate programs with specializations in forensic anthropology are keeping pace with the trends in the field. Do the current programs meet the philosophical and practical needs of the profession? Such efforts by the programs at Florida, Mercyhurst, Michigan State, and Tennessee will be presented.

A discussion of the differing goals of Masters and PhD programs is also important. Classically, the primary goal of PhD programs in physical anthropology is to produce academics. Has the increasing number of jobs in forensic anthropology impacted this goal? In addition, the role of Masters degree programs in forensic anthropology will be addressed. Does a Masters degree open up any doors in forensic anthropology, or is it simply a stepping-stone to a PhD program?

Finally, basic issues surrounding graduate student admission criteria need to be examined. With increasing student interest and an upsurge in the number of applications to graduate schools, the question whether graduate programs have a responsibility to limit the number of students accepted into programs needs to be discussed. Issues such as challenges to fund students, access to forensic casework opportunities, and the ability to place graduated students in the job market must be considered.

Changing role of forensic anthropology in medical examiner/coroner setting: Forensic anthropologists have long been consulted by medical examiners and coroners in jurisdictions across the United States. Historically, many were biological anthropologists who were either informally trained or self-taught with regard to the medicolegal aspects of the discipline. Primarily employed as university

professors, their involvement with forensic casework was due to their expertise with skeletal remains rather than their knowledge of the medicolegal structure. During the last twenty years, this model has evolved. Programs designed to train students in all aspects of forensic anthropology, including areas previously the domain of law enforcement and the legal community, arose and flourished. Doctoral and Master's level students were emerging with specialized knowledge designed specifically for the medicolegal arena, but they were still primarily involved with the academic community. The last ten years have seen a further evolution of forensic anthropologists employed in medical examiner and coroner offices, largely because of increased public, media, and professional attention on the field.

During the past year, several medical examiner offices in the United States advertised openings for full-time forensic anthropologists. These individuals will join a dozen or so practitioners already gainfully employed as full-time forensic anthropologists working at medical examiner or coroner offices. In addition, there are many more individuals whose primary occupation is serving medical examiners as consultants or contract employees.

The nature of the casework handled by these experts is also changing. In 1998, Reichs observed that between 1986 and 1995, approximately 47% of all casework reported by diplomates of the American Board of Forensic Anthropology was derived from medical examiner/coroner offices. In a small sample of forensic anthropologist currently working in the United States, this percentage has jumped to 85%. Similarly, Reichs reported that skeletal remains accounted for the majority of cases for most of the diplomates. This number has also shifted, with the sample polled demonstrating that decomposed and fresh bodies have increased substantially, and that the number of consultations involving the determination of traumatic injury to bone account for a large percentage of the caseloads.

Future of human rights work and humanitarian identifications: Over the past two decades, forensic specialists have played an increasingly active role in helping to expose the truth about violations of human rights and humanitarian law and in the humanitarian identification of victims of armed conflict and mass disasters. In the 1970's and 80's, the conflicts experienced by various countries throughout Latin America resulted in tens of thousands of disappeared persons. The first use of forensic anthropology to investigate these crimes was made in Argentina in the early eighties, resulting in the creation of a specialized team and the development of procedures later used elsewhere. In the mid 90's, scores of anthropologists and archaeologists of various nationalities were seconded to the Balkans to assist in the collection of evidence for the International Criminal Tribunal for the former Yugoslavia and to work with various organizations in the process of identification of the victims of the conflicts. Investigations continue there in what is, so far, the largest and costliest international forensic operation ever carried out to investigate the missing. The media attention given to the conflicts in the Balkans helped to sensitize the international community to the torment experienced by families who have lost a family member but are without news of their whereabouts. It also helped boost the forensic community's participation in clarifying the fate of the missing.

However, as the 21st century progresses, it appears that the forensic work in the Balkans can be considered the exception, not the rule. In most regions of the world in which people have gone missing, there are few, if any external organizations addressing the issue of the missing, and the constraints faced by investigators are often high, including lack of resources and security concerns. Thus forensic professionals find themselves stepping out of their traditional roles in the laboratory and the field to offer support and advice to a number of relevant actors in these contexts, from governmental authorities tasked with clarifying the fate of the missing, to family associations seeking psychological support, to local forensic professionals who are unfamiliar with the complex process of identification of large numbers of remains.

As forensic anthropologists and archaeologists continue to play an increasingly active role in exposing violations of human rights and

humanitarian law, it is imperative that tomorrow's scientists understand some of the legal, cultural and scientific challenges they may face when applying their skills and knowledge for humanitarian purposes.

Forensic anthropology and meeting evidentiary/legal demands:

The traditional definition of forensic anthropology as the application of physical anthropological analyses in a medico-legal setting is no longer sufficient to describe the current philosophical, methodological, and theoretical scope of forensic anthropology. In particular, methods developed within traditional physical anthropology are typically designed to address population level questions, not individual identity, and have little need to consider the potential legal and social ramifications of unreliable or inaccurate results. In contrast, forensic analyses must meet specific legal demands due to the evidentiary nature of the results. Because of the guidelines established from the United States Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals*, 113 S.Ct. 2786 (1993), and from the Canadian courts in *R. v. Mohan*, 89 C.C.C. (3d) 402 (1994), and in the wake of the United States v. Plaza, Criminal NO. 98-362 (2002), anthropological methods may be challenged in court. Thus, it is critical for forensic anthropologists to ascertain, under the rubric of evidentiary examination, the effectiveness of current analytical methods.

While the results of a standard biological profile are rarely the focus of courtroom testimonies, the submission of the forensic anthropological report places all of its contents under legal scrutiny. Furthermore, the forensic anthropologist must be cognizant of how analytical results are expressed within the report and on the stand. Quality assurance is necessary for all forensic anthropological methods to insure method transparency (e.g., recognize method limitations). Researchers must clearly state method accuracy and precision in a manner that is not only statistically significant, but also forensically meaningful. Research intended to conduct validation studies of existing techniques must be performed exactly as described; modifications by each new team of researchers produces unlimited new methodologies, not validations of existing ones. Standardization of research results, including appropriate statistical models and levels of precision, in the form of best practice protocols will help ensure the high quality of forensic anthropological research, and provide a secure foundation for forensic anthropologists in the courtroom.

Future of trauma analysis: Historically, the physical anthropologist identified "more or less skeletonized" remains, with occasional requests to "describe any evidence of bone damage" (Stewart 1979). The traditional role of forensic anthropologists never considered, much less allowed, debates of cause and manner of death because the academician, with skills rooted in skeletal biology, only worked on dry, unidentified skeletons associated mainly with cold investigations. Today, forensic science demands nothing less than circumstances of death. Anthropologists can no longer veil or ignore these issues or their consequences in court. The evolution in the courtroom parallels the changes occurring in the field as taphonomy and trauma (ante, peri, and postmortem) interpretations now occupy much if not most of forensic anthropologists' energies.

With the emergence of this 'new' forensic anthropology, professionals, for the first time, are seeing the potential of working alongside forensic pathologists and realizing the value of soft tissues. This partnership lays the groundwork for modern anthropological trauma assessment where the anthropologists are privy to smoking-gun investigations and eyewitness accounts. Eventually, in this scenario, bones are retained and processed free of soft tissue for closer examinations, as evidence. Trauma assessment in bone essentially remained stagnant in anthropology until the flesh was 'put back on' and the body, not just the skeleton, was examined. The role of forensic anthropology is evolving, with strides toward improved trauma and taphonomic assessments; keeping in mind, this is the only area of anthropology pressured by burden of truth.

Future of assessing ancestry: For most of the 20th century, American forensic anthropology approached ancestry as a three- or four-way decision: European, African, Native American, or sometimes Asian, reflecting its physical anthropological heritage and overarching American belief in the existence of discrete biological races. In the latter part of the

20th century, demographic realities and Repatriation legislation necessitated a finer-grained assessment of ancestry than the traditional racial approach: assessments such as "Mongoloid" or even "Native American" were no longer sufficient. Evaluating ethnicity to the tribal level has proven to be quite doable, and unusual comparisons such as Alaskan Eskimo or Indian vs. Chinese, Sioux vs. Chippewa, Mandan vs. Arikara, and many others have been successfully conducted using craniometrics, mandibular metrics, cranial angles, and postcranial measurements. The same is true for Hispanic groups from the Americas. The construction of databases, especially the Forensic Data Bank, has proven essential to recording and evaluating human skeletal variation geographically and temporally. Given the increased mobility of humans around the world and human rights cases emerging all over the globe, more remains from various parts of the world need to be documented and added to the existing databases in order to improve the precision and accuracy of evaluating ancestry. The affinities of unknown remains can only be judged by the comparative samples available.

During the 21st century, forensic anthropologists (and other forensic scientists) will abandon the race concept when generating the biological profile in favor of probable geographic origins. Evaluating ancestry will be much more appropriate, refined, and productive than assessing race. Craniometrics will continue to be used most extensively to quickly investigate possible ancestries, estimate sex, and find morphological outliers. Statistical methods integrating metric and non-metric attributes will be used more frequently. Given the changing demographics in the United States, all American forensic anthropologists will benefit from a ethnic or "tribal" outlook on human variation, minimally with the indigenous African, Asian, Caribbean, Central American, and South American groups continuing to migrate to the US.

Considerations for ethical standards in forensic anthropology:

Acceptable methods of handling human remains are decided by legal measures, professional standards and personal beliefs. For forensic anthropologists, professional standards are sketchy and behaviors are often influenced by the background of the individual investigator, circumstances of the death, and framework or level of institutional oversight.

Ethics is the judgment system by which the profession distinguishes acceptable and unacceptable behaviors. These beliefs are partly enacted into the legal system, detailing actions which are proscribed with appropriate forms of punishment or retribution activated within a statute of limitations. Some acts are not subject to criminal prosecution but are contestable in civil court.

Other actions, not illegal or formally contestable, are distasteful and seen as characteristic of someone not holding the same values as the majority of citizens. These acts may be viewed as evidence that the practitioner is greedy, self-centered, ignorant, misguided, or antisocial. Although punishment is not mandated, social repercussions may include diminished/destroyed reputation, shunning, or intervention.

Professional organizations codify the distinction of what is legal yet unacceptable into a Code of Ethics, outlining ideals to which all should aspire or characteristics of unacceptability. The authority behind these codes varies by organization. Some consider them merely a guide for good behavior while others strictly enforce them, barring violators from continuing membership.

Each individual is also guided by a personal code of ethics. This incorporates religious or spiritual beliefs and often reflects values with which each person was raised. There may be wide variation among individuals for acceptable personal behavior even though they may tolerate different behavioral expressions in others.

Handling of human remains are governed by legal requirements and by the personal code of ethics that each forensic anthropologist possesses. However, professional ethics cover only the expert witness aspect of the work and do not bear on the use of human remains in research and investigation. The forensic anthropologist faces a large "gray area" in which claims of scientific value, or "giving voice to the dead," only partly support his or her actions.

It is time that forensic anthropology held its place within biomedical research ethics where such guidelines are considered ubiquitous and universal. Professional standards could provide guidance if they acknowledge both research and casework functions. First, forensic anthropologists must conduct their work with respect to disciplinary standards – adequate sampling strategies, acknowledgement of confounding factors, transparency of methodology, replicability of techniques, and shared information. Second, forensic anthropologists must conduct their work with respect toward the victims whose remains are examined, their surviving families, and/or recognized representatives. Whenever possible, families should provide informed consent to the study and deceased's identity should be protected. When anatomical samples are taken, documentation should facilitate the repatriation back to the remains. Anatomical specimens should be retained only if other means of recording are inadequate for the study. Religious beliefs and cultural practices of the populations from which samples are drawn should be accommodated as much as possible. A common standard of ethics is difficult but not impossible to achieve and the authors hope to begin that conversation with this presentation.

Management of forensic laboratories and projects: Ironically, the relative “newness” of forensic anthropology as a recognized discipline is also one of its strengths within the increasingly complex and integrated world of forensic science. Training in forensic anthropology continues to be broad-based and closely tied to its roots in academic anthropology. For this reason, forensic anthropologists are trained in, or at least exposed to, a wide range of procedures, techniques, and paradigms, including anatomy, osteology, odontology, statistics, molecular biology, archaeology, geology, material-evidence analysis, and cultural relativity and sensitivity.

Anthropologists, by virtue of this broad academic training, are well suited to the task of overseeing and managing large interdisciplinary forensic projects in which the integration of disparate scientific fields is vital to a successful outcome. Further, many anthropologists who have become accustomed to directing research programs (such as large archaeological projects) accrue valuable management experience. Such projects typically present challenges of recruiting qualified personnel, managing multidisciplinary teams, working with limited budgets, coping with high personnel turnover, and timelines.

I Employment in forensic anthropology: Traditionally, forensic anthropologists were trained as academics, with employment coming from within the higher education system. Some anthropologists worked for the military and other government agencies, with research and consultation as their main focus. Forensic anthropologists conducted skeletal analysis for identification and associated interpretations, both as casework and for the development of new scientific methods. Their teaching responsibilities included training young anthropologists in the methods of forensic anthropology.

As the fourth era of the field defines itself, employment trends have seen forensic anthropologists using their skills beyond the traditional sphere. They are now employed in medical examiner offices, federal and state crime laboratories, disaster response agencies, non-governmental human rights organizations, and research institutions. This trend typifies the growth of forensic anthropology beyond skeletal casework. These jobs often include skeletal analysis as part of the responsibilities, but the actual position title does not usually say “forensic anthropologist.” As the next generation of forensically trained anthropologists begins their search for employment, trends in forensic science, societal pressures, and political agendas will impact areas of potential employment. A savvy forensic anthropologist may look outside traditional employment (i.e. in academe) to positions that may not list “forensic anthropologist” in the title. Federal agencies such as the Department of Homeland Security, the State Department, the Central Intelligence Agency, the Department of Justice, and the Department of Health and Human Services can benefit from broadly trained forensic anthropologists who can address complex questions in human identification, search/recovery, and medicolegal interpretation. Positions such as grant officer, scientific analyst, and

program analyst are well suited for anthropologists with broad forensic training. Areas such as biometrics, disaster fatality assessment, terrorism-related forensic issues, and cultural issues of crime in the global setting are just some of the areas where a broadly trained forensic anthropologist could participate. Government contract firms with forensic, biometric, and disaster focuses are another avenue of employment. Anthropologists are currently employed in non-governmental organizations involved in human rights and humanitarian issues (International Committee of the Red Cross, Physicians for Human Rights, International Commission for Missing Persons, and Equipo Argentino de Antropología Forense), both in technical (fieldwork) and program management positions. In state and local medical examiner/coroner offices and crime laboratories, forensic anthropologists have proven their value to the medicolegal investigative process. As this employment trend continues, the field must consider the development of training programs for such positions. Potential developments in science and culture that may impact future forensic anthropologists could include areas such as nanotechnology, DNA modification, new weaponry, the man-machine interface, human cloning, increasingly sensitive surveillance systems, and new types and definitions of crime and justice in an expanding multicultural society.

Forensic Anthropology, Future, Education

H52 A New Method for Evaluating Orbit Shape

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After attending this presentation, attendees will be introduced to a novel quantitative method of orbital shape analysis as it relates to discussions of sex and race in human skeletal remains.

This presentation will impact the forensic community and/or humanity by offering an alternative technique of data collection and analysis of human orbital anatomy.

Skeletal determination of race using orbital morphology is typically discussed qualitatively in terms of simple, descriptive labels (e.g., round, square, sloping, etc.). While inherently understandable, such labels are incapable of meaningfully characterizing the continuum of shape variability within and between human populations. Further, these descriptors rely upon individual subjective observation to demarcate between one character state and another. Moreover, even when measurements are taken of the orbital region, they are typically in the form of linear distance measures (height and breadth). The resultant orbital index is then partitioned into descriptive ranges of wide, average, or normal (Krogman 1962; Bass 1995). These established qualitative and quantitative methods of data collection may fail to capture all of the available information regarding individual and populational orbit shape.

The present study addresses this issue by applying 3D semi-landmarks to the orbital region. Semi-landmarks are often employed to capture anatomical structures lacking distinct landmarks, such as boundaries and surface curvature. One hundred twenty individuals evenly distributed by race (Black, White) and sex were compiled from the Terry Collection, Smithsonian Institution. Superior and inferior rim curvature for both orbits was captured by collecting a sequence of points along the structure's gross outline (continuous stream data) using a Microscribe® 3DX portable digitizer. The beginning and endpoints of the superior and inferior orbital curve corresponded to accepted landmarks (maxillofrontale and frontomale anterior). Semi-landmarks were then created within a beta program (Slice 2005), which applies an algorithm that resamples each curve into a user-defined number of evenly-distributed points (10 points per curve; four curves). The semi-landmark data were transformed by generalized Procrustes analysis (GPA), which optimally translates, scales, and rotates the points into a common coordinate system.

Multivariate statistical analyses were then performed on the resulting shape variables. In order to reduce dimensionality a principal component analysis (PCA) was performed on the covariance matrix of the aligned

coordinates. A multiple analysis of variation (MANOVA) was then conducted using the PCA scores to test whether sex and race have significant effects on orbit shape.

Both sex ($F=2.63$; $df=42$; $Pr>F<0.0001$) and race ($F=3.19$; $df=42$; $Pr>F<0.0001$) were found to significantly contribute to orbit shape variation. In addition, a significant sex*race interaction ($F=1.65$; $df=42$; $Pr>F<0.0301$) was detected. These results not only confirm previous gross morphological findings of racial variation in orbit shape, but indicate the presence of sexual dimorphism in this structure. Moreover, this method of data collection is not only fairly easy to master, but serves to better preserve the overall architecture of the orbits than traditional morphometric techniques. As such, these results indicate orbit morphology is influenced by both sex and race and the interaction of two.

Orbits, Shape Analysis, Semi-landmarks

H53 Morphological Characteristics of Ancestry in the Fetal/Newborn Human Skeleton

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After attending this presentation, attendees will understand features in the fetal/newborn skeleton that are associated with ancestral groups

This presentation will impact the forensic community and/or humanity by informing the community of the features in the fetal/newborn human skeleton that are disparate between ancestral groups, but to identify these features requires sub 0.1 millimeter accuracy in analysis.

This presentation is designed to inform the attendee of morphological and metric research to determine the validity of specific features in fetal/new born skeletal elements that may be used for determining ancestry. The attendee will obtain knowledge that the metric analysis applied in this study was at a too gross metric level to capture the subtle morphological differences that would determine ancestry in the human fetal/new born skeleton.

In the adult human skull, visual and metric assessment can often determine ancestry. Similar observations in the infant and sub-adult cranium have been attempted in the past with varying and usually ambiguous results. Previous observations during other research with the National Museum of Natural History (NMNH) fetal collections has identified that features of the maxilla, occipital bone and costal rib were visually disparate between individuals identified as White versus Black. In the maxilla, the nasal aperture appeared to be broader and the entire height of the maxilla is lower in Blacks. In the occipital, the alae on the lateral inferior portion of the squamosal area were more obvious in Blacks, the angle of the squamosal region and the basal region was more pronounced in Blacks, and the length of the basal section was longer in Blacks (associating with the longer and flatter basal section of the occipital as seen in Black adults). In the ribs, the shape of the costal end of the rib was more oval in Blacks and more round in Whites.

All individuals with a maximum left femoral length greater than 70.0 mm and less than 91.0 mm were evaluated for this analysis. The resulting total sample of 67 individuals was acquired for the four sub-groups: 25 Black males, 16 Black females, 11 White males and 15 White females. Any individuals with obvious pathological conditions, notated congenital defects, or cause of death (which would significantly cause insult to growth and development) were excluded from the study. Both metric and morphological assessments of the maxillary, occipital and rib features were conducted to evaluate the morphological and/or metric differences with relation to ancestral identification. All metric measurements were converted into indices to diminish size effect.

The most apparent result from this study was the negative influence from the gross incremental level of measuring the minute differences in

the observed features. In testing the inherent error, intra- and inter-observer variation was evaluated. Repeatability of the sub-millimeter values at the 0.01 mm level could not be achieved. Repeatability was acceptable at the 0.1 mm level. However, to accurately capture differences in features necessitates a level greater than 0.1 mm. This is not a fault in the measurer, but the methodology of the metric data capture of the morphology. Physical warping of some of the bones (due to maceration) also negatively contributed to the efficacy of this research design.

The above problem was exacerbated by the fact that as with most all studies involving sub-adult skeletal series, the results from this study are plagued by small sample sizes when divided into their sex and ancestry groups. The results from this study cannot provide reliable assessment for ancestry identification since no tests of significance can be administered. However, from the produced index means, there is a consistent trend in the shape of the costal end of the rib with relation to ancestry that agrees with the morphological expectations.

As an effort to avoid the measuring and repeatability problems, a preliminary investigation using 3D laser surface scanning of the maxilla and occipital is ongoing and at present has produced promising results.

Human Fetal Collections, Ancestry, Morphological Analysis

H54 The Curse of the Curvaceous Femur, the Litigious Line, and the Intrepid Investigator

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After attending this presentation, attendees will become familiar with the results of a two-pronged reliability test of an existing method for determining the ancestry of an unknown individual from the distal femur.

This presentation will impact the forensic community and/or humanity by offering an empirical assessment of the reliability of an often-used method for determining race.

It is well known that ancestry determinations using the postcranial skeleton are a difficult undertaking; very few methods are at the disposal of the forensic anthropologist. A method based on differences between the intercondylar shelf angle of the distal femur of American Blacks and Whites (Craig 1995) is one of the few available options. Since the Daubert decision, the forensic community has been increasingly concerned with the reliability of methods and observational data from which scientific conclusions are drawn. Within the biological sciences, this has led in some instances to the re-evaluation of previously published methods. In light of the rising awareness about the importance of method reliability, this study was designed to examine the inter- and intra-observer error associated with distal femoral measurements to determine race.

Four observers participated in the study using dry human bone housed at the Joint POW/MIA Accounting Command, Central Identification Laboratory. Each observer independently radiographed 33 whole or partial femora using a HOLOGIC RADEX Digital X-ray System. The radiographic protocols followed the Craig (1995) method and also utilized exemplars of "true lateral" positioning from a radiographic textbook. Each femur radiograph was then measured following the method's prescribed instructions. Repeated measurements were carried out with a minimum of 24-hours between measuring sessions in order to minimize short term memory bias. Each observer measured their own data set three times, and measured each other observer's set once. In toto, nearly 800 observations were conducted on the four independent sets of radiographs. Throughout the radiographic and measuring procedures, consultation between observers was prohibited.

The collected data was subjected to rigorous statistical evaluation through Students T-tests, ANOVA analysis, and summary statistics. Since this study focused on reliability of data/observations, all alpha levels were

set conservatively at 0.90. The average difference in trials per observer, regardless of direction, was 3.1 degrees. The range of variation was -15 to +11 degrees. In all cases, these differences are highly significant. Inter-observer error tests showed similar results. When inter-observer tests were conducted against a target response (the average of all twelve observations on each femur), significant differences were found for nearly every comparison.

Two clearly defined problems were identified in this study. First, delineating a radiographic true lateral position in dry bone was difficult for the investigators. Small positional differences of each femur increased or decreased the subsequent angle measurement. Second, aligning a ruler with the “distal one third of the femur parallel to the posterior cortex of the bone,” as prescribed in the method’s instructions was problematic. In most instances, femoral curvature was such that a parallel line was difficult to clearly and consistently define without landmarks. Also, the distal one third of the femur is a relatively arbitrary location, causing further discrepancies between investigators’ measurements.

Based on this study, the authors suggest that while the Craig (1995) method for assessing race has utility, specific radiographic positioning of dry bone and refined landmarks for the intercondylar shelf angle should be developed in order to minimize inter- and intra-observer error. For example, utilizing advanced digital imaging or clearly defining two points on the femoral shaft that would provide a means for drawing a consistent line parallel to the posterior cortex could be potentially useful refinements. It is anticipated that further experimentation will result in methods that decrease observer error and improve the method’s overall reliability.

Reliability, Racial Determination, Distal Femur

H55 Isotopic Determination of Region of Origin in Modern Peoples: Applications for Identification of U.S. War-Dead From the Vietnam Conflict II

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After attending this presentation, attendees will understand the benefits and limitations of undertaking a multi-element approach when utilizing stable isotopes for determining region of origin of human dental remains.

This presentation will impact the forensic community and/or humanity by providing information on a method that may facilitate identification of unknown individuals. The method uses multi-element stable isotope analysis of human dental tissues to suggest the natal origin of individuals. It is anticipated that this technique will be especially useful as a lead generator for human remains that have been recovered/obtained from either unknown, unreliable, or suspect contexts.

This study is novel in that it is the first of its kind, in a forensic setting, to compile a large reference sample of isotopic ratio values of multiple elements from individuals with known natal regions. The goal of the study was to create a database of “geolocational fingerprints” utilizing carbon, oxygen, strontium, and lead isotope ratios sampled from the teeth of modern people. This database is intended to assist in determining the region of origin for unidentified skeletal material without an established or well-documented provenance. The preliminary efforts of this project focused on determining the natal isotopic signatures individuals from Southeast Asia and the United States of America. These regions were primarily selected in order to assist the effort to identify the approximately

1,800 U.S. service personnel who remain unaccounted for from the Vietnam conflict, but the results also apply to the identification efforts for service personnel who are missing from the Korean War and the Pacific theater during World War II. The authors utilized the operating hypothesis that the isotope ratios incorporated into Southeast Asian and American dental enamel during childhood are distinct and that these differences can be used to determine region of origin.

An East Asian reference population of 61 individuals was sampled from the Joint POW/MIA Accounting Command-Central Identification Laboratory (JPAC-CIL) “Mongoloid hold” collection. This collection consists of remains unilaterally turned over to the CIL that have been identified as originating in East Asia, but that have been refused repatriation by their country of origin. The isotopic ratios derived from the enamel of the East Asian reference sample were compared against those obtained from the third molars of 228 patients who underwent recent dental extractions with the 10th Dental Squadron, United States Air Force Academy, Colorado Springs, Colorado. Living subjects completed surveys detailing their childhood residency and physiological, behavioral, and cultural factors that might potentially affect isotopic deposition in enamel.

While the ranges of all isotopes examined overlapped to an extent for the two populations, the least squares means for all isotope values examined exhibited statistically significant differences between the East Asian and American cohorts, based on the results of a conservative multivariate analysis of variance. A linear discriminant function was created that correctly classified individuals, through resubstitution and cross-validation, as belonging to one of these two groups by 95% or better. Strontium values from individuals reared for a portion of their childhood in the U.S. displayed a distinct trend toward homogenization, with the mean value for $^{87}\text{Sr}/^{86}\text{Sr}$ varying only slightly from that of seawater. Additionally, semi-quantitative calculations of enamel lead concentrations indicated the concentration of lead in the East Asian teeth was at least an order of magnitude greater than the American values, hinting at another potential discriminating factor.

When compared to isotopic signatures developed for geographic areas of Southeast Asia, the information in this study will assist in identifying the origin of unknown dental remains undergoing analysis by the JPAC-CIL. These data will serve as the foundation for a more comprehensive database of modern, human, geolocational isotope values that will assist not only in the identification of fallen servicemen and women, but could have potentially far wider reaching applications in the identification of victims of mass fatality incidents, undocumented and otherwise unknown suspected aliens who perish attempting entry into the U.S., and local “Jane and John Doe” cases by allowing for the inclusion or exclusion of potential matches based on geographic natal regions.

Stable Isotopes, Geographic Origin, Vietnam Conflict

H56 Richard Jantz: A Man of Impressive Numbers

Lee Meadows Jantz, PhD, Department of Anthropology, University of Tennessee, 250 South Stadium Hall, Knoxville, TN 37996*

After attending this presentation, attendees will learn about the impact Richard Jantz has had on the field of Forensic Anthropology.

This presentation will impact the forensic community and/or humanity by demonstrating the professional contributions Richard Jantz has made in the field of forensic anthropology.

Richard L. Jantz was born in a rural Kansas farming community a while ago. He was raised in Halstead, KS, where his parents still reside. He attended University of Kansas for his undergraduate and graduate degrees, studying under the greats such as Bass, Kerley, and McKern, studying along side other notables such as George Gill, Doug Ubelaker, and Ted Rathbun. His early research in human variation yielded his MA

thesis, *Some Aspects of Laterality in University of Kansas Male Students*. His doctoral research focused on skeletal research, specifically cranial variation in Arikara. It was during this period of his career that he began to appreciate the contributions of WW Howells. These themes have carried through his very productive career.

Richard's first academic position was held at the University of Missouri, where he worked for a year as an instructor prior to finishing his degrees. He followed this with a short two-year stint at the University of Nebraska. He was an instructor, then after receiving his PhD, became an assistant professor. While he was a Plains man, he realized that it was really too cold in the winter. When Bill Bass called him from the warmer climes of East Tennessee to offer him a position, he was more than willing to make that move. Thus began his 36-year (and continuing!) career at the University of Tennessee.

Numbers are this man's game. Working with students and colleagues, Richard has developed several different databases including one for dermatoglyphics (with the late H. Brehme), Plains skeletal metrics (with D. Owsley, P. Key, and T. Zobeck), the Boas anthropometric data (with D. Hunt), and probably the most familiar to this audience, the Forensic Data Bank (with many of you). Following in the footsteps of Howells, Richard's practice of sharing the wealth of data has allowed many researchers to contribute to the field of study.

Continuing in this vein, data requires statistical manipulation. Although not a computer geek, Richard is a number cruncher. He has provided statistical advice and analysis to innumerable students and practitioners in the field. A major contribution to the area of forensics is FORDISC (now available in its third version), the custom discriminant function software developed by Richard and his student/colleague, S. Owsley. FORDISC has changed the way most forensic anthropologists approach the analysis of unidentified skeletal remains today.

Richard has been relatively lucky in his career as a professor. He has many wonderful students as illustrated by this session. After a student graduate, he considers him or her a colleague as evidenced in his many collaborations. While this session is in honor of his career, let it be known...his career is not over. He is looking forward to many more interesting projects as well as hopefully finishing many of the ones in which is currently involved.

Jantz, Forensic Anthropology, Databases

H57 Estimating Geographic Ancestry of Hispanic Crania Using Geometric Morphometrics

Katherine M. Spradley, PhD, and Bridget F.B. Algee-Hewitt, MA, The University of Tennessee, Department of Anthropology, 250 South Stadium Hall, Knoxville, TN 37996*

After attending this presentation, attendees will understand the use of geometric morphometrics in ancestry estimation.

This presentation will impact the forensic community and/or humanity by addressing the issue of ancestry determination of Hispanic individuals using geometric morphometric methods.

Correct ancestry estimation for American Blacks and Whites is possible due to documented reference samples such as Terry, Todd, and more recent collections including the William M. Bass Donated Collection, and the Forensic Anthropology Data Bank (FDB). However, there is no Hispanic equivalent of these large reference collections. The increasing Hispanic population in the U.S. makes it necessary to obtain appropriate reference samples for ancestry determination. Because there is no large reference collection of recent forensic Hispanic skeletons, cases from forensic anthropologists around the country must be relied on to better understand and identify the increasing number of Hispanic skeletons found in a forensic context.

Traditional craniometric morphometric methods in addition to years of experience are widely employed in ancestry determination. Results presented at this meeting by the first author (2004) suggest that traditional craniometrics, at best, provide a 45% classification rate (cross-validated) for Hispanic individuals when compared to American White, American Black, Guatemalan Mayan, and Argentinean samples. Because Hispanic individuals are a hybrid population of European and Indigenous Spanish-speaking individuals, correct ancestry estimation is more problematic. Geometric morphometric methods are suggested to better discriminate among groups that are closely related.

This presentation uses three-dimensional landmark data to examine the morphological differences between size and shape in Hispanics, American Whites, and Guatemalan Mayans. Because it is important to use samples that represent recent forensic anthropological cases that are seen in the U.S., for this analysis, Hispanics (n = 41), American Whites (n = 57), and recent Guatemalan Mayans (n = 70) were used as reference samples. The Hispanic and American White samples are from the Forensic Anthropology Data Bank (FDB) and were collected by the first author. The American Whites are positively identified individuals and the majority of the individuals are from Tennessee.

The Hispanic sample used in this paper contains either positively identified or contextually identified individuals. Individuals in the latter group are from U.S. border crossing fatalities found by immigration officers patrolling the border. Of the border crossing fatalities, only individuals with enough soft tissue present to indicate a positive identification of sex were used. The Guatemalan Mayan sample was collected from the Forensic Anthropology Foundation of Guatemala (FAFG); this is a recent forensic sample and consist of mostly male individuals. The context is modern Mayan, from Rabinal and Comalapa, and are either positively identified or contextually identified.

Landmarks (n = 35) were chosen that represent the overall cranial vault and face. A general Procrustes analysis was performed in Morphologika 2 (O'Higgins and Jones, 2006) and a discriminant function analysis was run in SAS 9.1 (SAS INSTITUTE). The cross-validated classification rate for Hispanic individuals using geometric morphometric methods is 80.5%, an improvement from the 45% utilizing traditional morphometric methods. Results will be presented along with a discussion of the major morphological differences between Hispanics, American Whites, and Guatemalan Mayans.

Ancestry, Hispanic, Geometric Morphometrics

H58 Morphological Variation in the Cranial Base: Implications for Sex and Ancestry Estimation

Ashley H. McKeown, PhD, Department of Anthropology, University of Montana, Missoula, MT 59812; and Daniel J. Wescott, PhD, Department of Anthropology, University of Missouri, Columbia, MO 65211*

After attending this presentation, attendees will understand the patterns of morphological variation of the cranial base that characterize males and females and American whites and blacks and how this variation can be used to estimate sex and ancestry for unknown individuals.

This presentation will impact the forensic community and/or humanity by demonstrating how differences in the cranial base between males and females are primarily due to size, while variation among American whites and blacks are primarily due to shape. These patterns must be acknowledged when estimating sex and ancestry from this region of the human cranium.

This research uses three-dimensional coordinate data observed on crania from known sex and ancestry collections and the tools of geometric morphometrics to evaluate morphological variation in the cranial base.

Standard statistical analyses are employed to assess the utility of using the size and shape variation to estimate sex and ancestry.

Variability in craniofacial morphology has been used successfully to estimate sex and ancestry for unidentified skeletal remains. While research has focused on the variation present in the face and cranial vault that permits relatively accurate assessments of sex and population affiliation, investigations into the morphological variation of the cranial base have been limited. Nevertheless, the research conducted thus far does suggest the presence of sex and ancestry based variation in the dimensions of the cranial base. As anthropologists are often confronted with fragmentary cranial remains, approaches to sex and ancestry estimation that utilize the cranial base can be useful. To further investigate the nature of the variation and assess its utility for sex and ancestry estimation, differences in size and shape are evaluated using three dimensional coordinate data observed on crania from known sex and ancestry collections.

The sample is comprised of crania of known sex and ancestry (American white and blacks) from the William M. Bass Donated Skeletal Collection (n=56) housed at the University of Tennessee and the Terry Collection (n=340) housed at the National Museum of Natural History, Smithsonian Institution. Sixteen landmarks from the cranial base were recorded as three dimensional coordinates and used for the analysis. The coordinate data was subjected to Procrustes fitting via a general least squares procedure that orients the configurations in a common coordinate system and scales the configurations to remove size differences. Size is retained in the centroid size for each configuration which permits the inclusion of this variable in analyses. Using the tools of geometric morphometrics, the fitted coordinates are used to explore shape variation between the sexes and among the groups. Further analyses based on the fitted coordinates and centroid size, including principal components and canonical discriminant analysis, were used to evaluate whether the size and shape variation present among the groups is useful for estimating sex and ancestry.

Differences in the cranial base between males and females are primarily due to size, while variation among American whites and blacks are primarily due to shape. These patterns must be acknowledged when estimating sex and ancestry from this region of the human cranium.

Sex, Ancestry, Geometric Morphometrics

H59 Craniometrics as Jantz Taught Us: Multiple Lines of Evidence to Deduce the Affiliation of Painted “Aztec” Skulls

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After attending this presentation, attendees will understand how to use linear and three-dimensional coordinate data in discriminant function analyses to verify the national or ethnic affiliation of crania of unknown geographic and temporal origin. Participants will also develop an appreciation for the necessity of considering and evaluating other types of evidence including reported mortuary practices and artistic representation when concluding national and/or ethnic origin.

This presentation will impact the forensic community and/or humanity by demonstrating the importance of using multiple lines of evidence to differentiate “historic” from forensic cases. This presentation also illustrates multiple statistical methods for estimating national and ethnic affiliations.

Five painted adult skulls, reported to be pre-contact Aztec, were at various times on exhibit at the Field Museum of Natural History in Chicago, Illinois. Documentation pertaining to acquisition reveals little information about provenience. The markings on the skulls are elaborate, decorative, colorful, and primarily geometric in design. The morphology of the skulls suggests a more recent origin than 400 – 800 years ago. Additionally, the skulls lack any “indigenous” traits that would be expected to characterize pre-contact Mexican remains. The authors of this investigation thought that the postmortem modifications in the form of these elaborate paintings, as well as the inconsistent morphology were highly suspicious. To authenticate the origin of the skulls, three lines of evidence are used; 1) traditional craniometrics analyzed using FORDISC, 2.0 and the known samples that comprise the associated craniometric database, 2) 3D Cartesian coordinate size and shape variables using regional data from Central America, and 3) bioarchaeological, archaeological, and ethnohistorical evidence of documented mortuary and other cultural practices of the Aztec. The inclusion of the third line of evidence highlights the application of the biocultural approach, the methodology of which puts the “anthropology” in “forensic anthropology.”

First, using FORDISC 2.0 American Hispanic males (which in this version of FORDISC primarily consist of individuals of Mexican descent) as well as White, Black, and American Indian males and females are used in a discriminant function analysis to classify the “Aztec” skulls. Two of the five skulls classify as White Females. The other three skulls each classify as a Hispanic Male, American Indian Male, and Black Male, respectively. Finding that the population variation of the five skulls is highly heterogeneous suggests they are not of pre-contact “Aztec” origin or even from a single population.

To further investigate the possible origin of these skulls, the authors present the among-sample variation and classification results using three-dimensional landmark coordinates of the skulls when compared to samples of pre-contact Mexicans from Tezontepec (n = 6), 20th century Mexicans from Tarasco (n = 20), and documented samples of Spanish (n = 20), American Whites (n = 20), and Terry Blacks (n = 20). The landmark-based Procrustes superimposition approach, based on geometric morphometry, was used. Thirteen standard craniometric landmarks were used to reflect the among-group variation. A multivariate analysis of variance (MANOVA) and Mahalanobis squared distances (D^2) were used to examine group membership.

Given the possible age(s) and cultural affiliation of the 5 skulls in question, bioarchaeological, archaeological and ethnohistorical sources of information on Aztec mortuary ritual and other cultural practices were consulted and the data derived from them are incorporated into the final interpretation regarding national, ethnic, and/or ancestral affiliation(s). Variables are identified that represent documented alteration for aesthetic or cosmetic purposes, body preparation after death, and disposition practices, including evidence for cranial shape modification, dental alteration, painting, incising, carving, burning, dismemberment, and cannibalism. Central to the verification effort, was not only a comparison of the five skulls to the forensic databases available, but to consider the biological and cultural distinctions between groups living within the Aztec sphere of influence in order to narrow the possible ethnic or ancestral affiliation. These groups include those of the Triple Alliance that maintained their own cultural identity, those that succumbed to Aztec social and political influence, the Aztec, and those that were sacrificed as part of ritual offerings.

This study serves as a reminder that the line between historic and forensic, “Hispanic”, “American Indian” or “Other” may be blurred. Careful consideration of multiple lines of evidence, including cultural practices, and the aid of statistical modeling as offered through FORDISC and modern methods from geometric morphometrics are imperative anthropological tools.

Craniometrics, Classification, Authentication

H60 Repeatability and Error of Cranial Landmark Coordinates

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After attending this presentation, attendees will be introduced to issues of intra- and inter-observer error in the collection of three-dimensional landmark coordinates.

This presentation will impact the forensic community and/or humanity by addressing issues of repeatability and error in geometric morphometric methods of data collection.

Historically, size and shape analyses have relied on the application of multivariate statistical methods to linear distances, ratios, and/or angles derived from caliper measurements (Lynch et al. 1996; Rohlf and Marcus 1993; Ross et al. 1999). One of the limitations of caliper derived metric data is that the measurements are confined to the positions of the caliper endpoints, which are defined by anatomical locations or landmarks. The end result is a linear distance measure incapable of fully capturing all of the information available about the relative positions of these landmarks in space (Bookstein 1991).

Modern methods of the geometric morphometrics address many of the shortcomings associated with traditional metrics by focusing on the analysis of landmark coordinates (Rohlf and Marcus 1993). Unlike traditional metrics, coordinate data fully archive all of the geometric information available in the anatomical structures. These newer three-dimensional methods have gained much popularity in physical anthropology over the last decade being adopted by many evolutionary theorists, clinicians, and forensic anthropologists. Data capturing techniques range from direct digitization of landmarks via 3D digitizers to point extraction from scanned images. However, these new modes of data acquisition and analyses have undergone little to no systematic testing for accuracy. The purpose of this study is to evaluate the repeatability and error associated with the collection of cranial landmark data using these newer modalities. Three skulls were selected for this study from the C.A. Pound Human Identification Laboratory. Nineteen standard homologous cranial landmarks were collected using a Microscribe 3DX and G2X ® digitizer and the software ThreeSkull written by Steve Ousley. Each skull underwent three separate digitization sessions by two separate observers for a total of six digitizations for each skull. Because the skulls were not “fixed” in a common coordinate system between digitizing sessions, interlandmark linear distances (ILDs) were used in the subsequent statistical analysis rather than the landmark coordinates. All possible ILDs between the nineteen landmarks ($n = 171$) for each digitizing session ($n = 3$) for each observer ($n = 2$) for each skull ($n = 3$) were calculated using the program PAST (Paleontological Statistics, 2001, <http://folk.uio.no/ohammer/past/download.html>). Digitization error (within-subject error or the proportion of the total variance explained by multiple digitizing sessions of the same skull) was tested using a mixed model analysis of variance (ANOVA). Sixteen percent of the 171 ILDs showed error in excess of five percent. Repeatability (between-observer variation) was tested using ANOVA using the general linear model (GLM) routine. Significant between-observer difference was found for fourteen ILDs. The majority of the between-observer variation included Type III landmarks (e.g., alare and euryon). These landmarks are fairly accurate when instrumentally derived as linear distances in traditional morphometrics (e.g., maximum cranial breadth or XCB). However, they are highly variable when attempting to archive their exact anatomical location and the authors caution the use of Type III landmarks in geometric morphometrics.

Cranial Landmarks, Repeatability, Geometric Morphometrics

H61 Morphological Variation of the Human Knee: Implications for Sex and Ancestral Designations

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The goal of this presentation is to present to the participant of the results of analyses designed to describe the observed variation in the human knee joint based on age, sex and ancestry. The attendee will learn of the trends in morphological variation of the knee and the implications for both the forensic and medical communities.

This presentation will impact the forensic community and/or humanity by demonstrating the utility of the observed variation found in this analysis of the knee joint may be used to differentiate between living populations allowing sex and ancestral designations to be made in a forensic context.

The clinical literature has noted variation in the knee joint, for the purposes of knee related surgeries, between male and female individuals of African and European ancestry. This observed variation is critical to pre-surgical planning for repair and or implantation of artificial devices. Similarly, these authors (Waxenbaum et al. 2006) highlighted significant variation in the intercondylar eminence length of the proximal tibia which was attributed solely to population (evolutionary ancestry) and not found to be influenced by either sex or age. This presentation expounds upon previous analyses in order to determine whether other factors of size and/or shape of the distal femur and proximal tibia correlate to the population variation in the knee previously detected.

Eleven measurements (five of the distal femur; six of the proximal tibia) were added to the two measurements for each individual from the previous analysis for a total of thirteen measurements. Four populations of individuals were analyzed - (all material used in this analysis is housed at the National Museum of Natural History, Smithsonian Institution) Terry White ($n = 94$), Terry Black ($n = 100$), Eskimo and Aleutian populations from Alaska ($n = 201$), and a population of Arikara from South Dakota ($n = 120$). Individuals were sampled from both sexes and were separated into “older” and “younger” categories for age analysis given the archaeological nature of the Alaska and South Dakota remains.

The original intercondylar eminence data were re-analyzed including a small population of male, Chinese individuals ($n = 51$) and the previously detected trends held; neither sex nor age made a significant difference in the length of the proximal tibial eminence. However, population remained a significant factor ($P < 0.001$). When the eleven new measures of the proximal tibia and distal femur were analyzed similar trends emerged. While all new measurements displayed a significant ($P < 0.001$) population effect they also revealed a significant ($P < 0.001$) sex effect. Eight of the eleven measures additionally exhibited a significant population-sex interaction ($P < 0.050$).

Thus, these new data the gross morphology of the knee are dependent on within population sex differences and overall differences between populations.

While a direct explanation of this variation cannot be pinpointed, physical anthropology often highlights the morphology observed among diverse ancestral populations in terms of size, shape and proportionality. The authors postulate a combination of all of these factors, throughout the course of human evolution, has caused the functional change in knee joint highlighted in this analysis. The utility of the observed variation may be used to differentiate between living populations allowing sex and ancestral designations to be made in a forensic context.

Knee, Population Variation, Metric Analysis

H62 Sex Determination in the Human Sacrum: Wing Index and Sacral Curvature

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After attending this presentation, attendees will learn about results in the use of wing index as a criterion for sex determination and the variation found in the wing length of the sacrum. This presentation will also inform the attendee of the use of sacral curvature for sex determination. The participant will be familiarized with the morphological variation of the sacrum and its value as an element for sex identification in forensic anthropology.

This presentation will impact the forensic community and/or humanity by confirming that there is no significant difference in sacral wing width for both sexes in American Whites and Blacks and that the significant sex differences found in sacral curvature allows for general sex determination. However it is clear from this study that the range of variation in the sacrum is highly influenced by development in the axial skeleton. This greatly affects its morphology and using the sacrum as the single element for sex identification should be employed with caution.

The goal of this presentation is to inform the attendee results in the use of wing index as a criterion for sex determination and the variation found in the wing length of the sacrum. This presentation will also inform the attendee of the use of sacral curvature for sex determination. The participant will be familiarized with the morphological variation of the sacrum and its value as an element for sex identification in forensic anthropology.

Physical anthropology literature in the last 100 years has noted variation and sex differences in the human sacrum. In 1982, Kimura studied sex differences in the sacrum by the base-wing index using American Black and White individuals from the Terry Collection (National Museum of Natural History) and Japanese individuals from the Department of Anatomy, Yokohama City University School of Medicine. When measuring the wing of the sacrum, Kimura only measured the right side in response to the findings by Matsui in 1942 that the sacral wing was greater on the left side than on the right in Japanese skeletons for both sexes. However, Kitano (1959) found there was no significant difference in the right and left wing in Japanese individuals for both sexes. The present research assesses the variation among sacral wing widths in a sample of American Black and White individuals in order to gain further understanding in the utility of the sacral wing index as a sex determinant and to clarify disparity in previous publications.

Bass has identified sacral curvature as a sex identifier, yet no citations or references were indicated to studies that assessed the accuracy of this characteristic of the sacrum being flatter in females and more curved in males. This present study examines sacral curvature as a criterion for sex identification.

Three hundred individuals were measured in this present study using the Terry Collection at the National Museum of Natural History. Subgroups of the sample were divided equally between the sexes and between "racial" groups of American Blacks and American Whites based on the identification of the ethnic affinity assigned to the individual at autopsy. The wing of the sacrum was measured from the lateral margin of the articular base to the most lateral border of the wing. The sacral curvature was measured sagittally (using a coordinate caliper), on the ventral side from the most anterior superior point of the articular promontory to the most anterior inferior portion of the coccyx, the depth of the curvature was derived by measuring at the deepest point of the sacral body.

Overall results from the study for wing length found for the right wing (in millimeters): Blacks=30.83 ± 3.63; Whites=34.36 ± 3.83; Males=31.25 ± 4.24; Females=33.95 ± 3.52. For the left wing: Blacks=30.70 ± 3.68; Whites=34.41 ± 3.74; Males=31.06 ± 4.20;

Females=34.04 ± 3.53. Within the ancestry and sex groups there is no significant difference between the mean lengths of the right and left sacral wing. However, there are significant differences ($p=0.000$) in the mean wing values between Blacks and Whites and between males and females.

Results from the sacral curvature means (in millimeters) are: Black Males=15.72 ± 6.34; Black Females=12.88 ± 6.58; White Males=20.06 ± 7.74; White Females=17.17 ± 7.74. Tests of significance found that two groups do not have significantly different means (Black females and Black males, $p=0.212$; and White females and White males, $p=0.024$), all other groups are significantly different at the $p=0.01$ level or greater. Sectioning points and confidence intervals will be presented for group identification.

This study confirms that there is no significant difference in sacral wing width for both sexes in American Whites and Blacks, and the significant sex differences found in sacral curvature allows for general sex determination. However, it is clear from this study that the range of variation in the sacrum is highly influenced development in the axial skeleton. This greatly affects its morphology and using the sacrum as the single element for sex identification should be employed with caution.

Sex Determination, Sacrum, Sacral Curvature

H63 New Statistical Approaches to Sex Estimation: Multi-Stage Discriminant Function Analysis

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After attending this presentation, attendees will understand sex estimation from skeletal remains is based predominantly on overall size, significant shape differences between male and female crania, and that discriminant function analysis (DFA) is a powerful tool for analyzing skeletal data and accuracy can be enhanced through multiple analyses utilizing size and shape variation.

This presentation will impact the forensic community and/or humanity by providing a better understanding of sexual dimorphism expressed by metrics.

Absent the bones of the pelvis, sex estimation from skeletal remains in forensic anthropology is often based predominantly on overall size, so small males and large females are more likely to be misclassified. Because there are different levels of sexual dimorphism and different sizes for the various populations in the world, an incorrect estimation of sex from skeletal remains can drastically affect ancestry assessment and vice-versa. Seriation (e.g., Rogers 2005) is not always an option and will likewise misclassify small males and large females.

Forensic anthropologists have been employing DFA to determine sex from crania for decades. The classic papers by Giles and Elliot in the 1960s provided numerous functions that permitted anthropologists to address questions of sex and ancestry using cranial measurements. More recently, FORDISC uses reference data from numerous human populations to calculate custom discriminant functions suited to a specific case, and some versions included a sex-only function, which combined the male and female samples of American Whites and Blacks. However, as Damann and Byrd (2004) demonstrated, DFA using raw measurements will tend to misclassify small males as female. This is especially true for groups with relatively small crania such as Hispanic males from the Southwest U.S. An incorrect sex assessment in the biological profile may affect the evaluation of ancestry and will hamper a positive identification.

There are various statistical methods for analyzing measurements from males and females, including using sex-centered means, extracting principal components and analyzing all but the first principal component, calculating shape variables (Darroch and Mosimann 1985), and calculating C-scores (Howells 1995). The latter method was

recommended by Damann and Byrd (2004). Fordisc 3.0 (Jantz and Ousley 2005) allows the user to transform measurements into shape variables and then perform DFA on them. The flavor of DFA used is a linear discriminant function, though other methods such as quadratic DFA, nearest neighbor analysis, and kernel discriminant analysis can be employed as well.

Using 23 measurements from 171 white males and 100 white females, Fordisc 3.0 was 90% accurate in determining sex, crossvalidated. When shape variables were analyzed, the accuracy dropped to 83%, confirming that size differs between males and females, but also that shape differs significantly between them. More importantly, when the individual classifications were examined, 7 of the 17 males misclassified in the analysis using size and shape were correctly classified when using shape alone; 3 of the 10 females misclassified in the analysis using size and shape were correctly classified when using shape alone. Therefore, a Multi-Stage Discriminant Rule (MDR) utilizing both analyses is: If the size and shape classification of a cranium is male, accept the classification; if the size and shape classification is female, change the assessment to male if it classifies as a male using the shape variables. Following this rule results in classifications that are 94% correct for the white sample. Also, there were no indications of variance-covariance matrix heterogeneity.

While the use of shape variables clearly provides greater accuracy within Whites, there appears to be generalized sex differences that are expressed in relative size and/or shape in all groups: When 274 females and 465 males from several different recent populations were analyzed sex functions were obtained with somewhat reduced accuracy compared to Whites alone. However, results were encouraging using stepwise variable selection, with as few as 12 variables providing classification accuracies of at least 90%, though the most valuable shape variables were largely independent of the most valuable size variables. In looking at how Hispanic individuals classified using stepwise methods on combined recent populations, all 11 females were classified correctly using size and shape; 41 males were classified 90% correctly using size and shape, 83% using shape, and 95% correctly using the MDR.

Most of the metric variation between males and females has been thought to be due to size, but shape is also important. Combining multiple classification tools such as stepwise variable selection, different classification methods, and multiple steps can optimize sex classification accuracy. These tools can also be utilized with data from landmark coordinates and interlandmark distances (nontraditional craniometrics) to further improve sex classification.

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Discriminant Function Analysis, Craniometrics, Sex Estimation

H64 The Value of Experience, Education, and Methods in Ancestry Prediction

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After attending this presentation, attendees will be introduced to the results from a survey conducted at the 58th Annual Meeting of the American Academy of Forensic Science in Seattle, WA.

This presentation will impact the forensic community and/or humanity by providing insight into the value of experience, education, and methods in ancestry prediction.

At the 58th Annual Meeting of the American Academy of Forensic Science in 2006, the authors conducted a volunteer survey and exercise to examine the methodological approaches to sex and ancestry determination. Exercise participants were asked to rank the techniques they use and to determine the sex and ancestry of seven specimens. A total of 76 individuals participated in the survey. Participant education levels included 15 with Bachelor degrees, one DDS, three MD, 22 Masters, 35 PhD, and one "other." Additional information from participants included the number of crania examined, years of professional experience, preferred methods of sex and ancestry determination, classes taught, etc. This presentation will focus on the determination of ancestry.

Results support the adage "experience matters," but only to a point. Individuals with advanced degrees performed superior to others and, as would be expected, individuals with an anthropology background performed better than those outside of the field. Correct estimation of ancestry for all seven crania by education level is as follows: MDs (19%), DDS' (28.6%), BS/BA (31.4%), MS/MA (42.2%), PhD (43.3%). Among anthropologists, experience levels ranged from 0 years to more than 30. To determine experience levels for Masters, mean years in school was added to mean years of professional experience to equal a mean of 8 years of experience. PhDs had a mean of 13.5 years, indicating a considerable difference in the experience levels between Masters and PhDs. Despite the large disparity in years of professional experience, participants with Masters degrees performed about as well as PhDs.

To determine if the number of correct ancestry estimations is significantly related to factors such as "level of education," "number of crania examined," and "number of years as a professional," a Kruskal-Wallis analysis of variance test was performed. Significant interaction was noted for several key factors related to experience, but not degree level (e.g., Bachelors vs. Masters or Masters vs. Doctoral). For example, the total number of years as a graduate student was significant ($p < 0.05$, assuming χ^2 with 6 df), specifically for several problematic crania like the Hispanic individual. The number of years as a professional was also significant ($p < 0.05$, assuming χ^2 with 6 df) for the Black male. This suggests the obvious: the more human variation someone has observed, the higher the likelihood of arriving at a correct evaluation. However, the parametric tests for experience and number of crania examined were not significant, and there are some indications that the methods and/or traits used influence the likelihood of being correct the most.

Correspondence analysis (CA), an ordination procedure used to map out the relationship of variables to one another in multivariate space, was used to explore other aspects of the results. Participants were asked to describe and rank the methods they prefer to use when determining ancestry. Results of the CA demonstrate that persons with Bachelor degrees prefer to use basic, pre-defined characteristics such as "facial prognathism." Masters students prefer multi-state morphological variants such as "the shape of the zygomatic" or multiple aspects of "the midfacial skeleton." Surprisingly, more Masters students cited "metric analysis"

than did PhDs, suggesting a generational shift in emphasis to metric analyses. Those with PhDs present the most surprising results. PhDs are associated with the following responses: “nasal morphology,” “nonmetric,” and “none.” These results suggest that PhDs rely on aspects of morphology not readily defined, perhaps Stewart’s (1979) “indefinable something.”

Taken as a whole, the results imply that White crania may be more often estimated accurately: 92% of all participants correctly assessed ancestry for the White female. This result may be due to more frequent exposure to Whites in reference skeletal collections. The Hispanic individual was the most difficult for participants to correctly classify: only 11% of the participants answered correctly, a pressing problem which may be due to a lack of Hispanics in collections as well as their mixed ancestry. There were also significant indications of ambiguity in assessing ancestry, which may be due to the presence of discordant traits within individuals. “Mixed ancestry,” or a similar response was used as a designation 22 times, six times alone for the black male case consisting of a cranium and femur, which appeared to have nonmetric traits traditionally associated with both American Whites and Blacks. In several cases, participants weighted certain traits more heavily than others, despite a declared preference for other traits. In other words, it appears that the relative importance of traits in assessing ancestry is adjusted based on the case under examination, and may reflect *post hoc* trait selection after a general impression is formed, as suggested by Hefner and Ousley (2006).

Table 1. Percentage of Masters and PhDs correctly estimating ancestry.

CASE	M.A./M.S. (n = 22) % Correct	PhD (n = 35) % Correct
East Asian	63.7	60.0
White	91.0	94.3
Hispanic	9.1	14.3
Black	18.2	22.9
East Asian	50.0	62.9
Black	31.8	20.0
American Indian	31.8	31.3
Overall % Correct	42.2	43.3

References:

¹ Stewart, TD (1979) *Essentials of Forensic Anthropology*. Springfield, IL: Charles C. Thomas.

² Hefner, JT and SD Ousley (2006) *Morphoscopic Traits and the Statistical Determination of Ancestry II*. Proceedings of the Annual Meeting of the American Academy of Forensic Science, 58th Annual Meeting, Seattle, WA.

Ancestry, Nonmetrics, Correspondence Analysis

H65 Using Growth Data to Understand Secular Trends in Femur Diaphyseal Size and Shape among American Adults

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The goal of this presentation is to demonstrate the secular changes in femur size and shape that have occurred among Americans born in the 1840s to the 1980s. The relationship between size and shape variables during growth will then be used to explain the likely proximate causes for the observed secular changes. Attendees will learn how stature, body build, and physical activity interact during life to establish adult femur morphology, and will also gain an appreciation of the impact that femur secular changes can have on the interpretation of modern forensic cases.

This presentation will impact the forensic community and/or humanity by demonstrating demonstrating that femur morphology is

constantly changing and that methods for estimating sex from the femur, ancestry, and stature, most of which are derived from nineteenth century skeletal collections, must be constantly reassessed and renewed.

Secular changes in skeletal morphology have the potential to impact the validity of methods used by forensic anthropologists for developing an accurate biological profile. From the 1840s to 1980s, the femur has undergone significant secular changes among American Blacks and Whites. In general, the femur has increased in length, decreased in robusticity, and the midshaft diaphyseal shape has changed from relatively circular to anteroposteriorly (AP) elongated due to a decrease in the mediolateral (ML) dimension. Interestingly, femur head diameter, midshaft AP diameter, and subtrochanteric shape have not changed significantly during this time. Increases in femur length are most likely due to dietary and healthcare improvements, but secular changes in diaphyseal size and shape are usually thought to be associated with decreases in physical activity levels, especially terrestrial mobility, through time. However, the patterns of change in diaphyseal morphology, especially midshaft shape, do not correspond to those expected based on a decrease in terrestrial mobility alone. A biomechanical model would predict that a simple decrease in activity levels should result in the femur diaphysis becoming smaller through time but retaining a relatively circular midshaft shape.

Secular changes in femur morphology are demonstrated using measurements from 962 American adults with birthdates ranging from the 1840s to 1980s. To investigate the proximate causes for the secular change among American adults, patterns of change in femur diaphyseal shape, AP and ML diaphyseal dimensions, head diameter, and length during growth were examined using a sample of 64 subadults (birth to 18 years of age). No significant sex differences in the patterns of growth were observed, so subadult males and females were pooled. Regression analysis was used to examine the correlations and partial correlations between variables during growth.

The results show that subtrochanteric shape does not change significantly ($r^2 = 0.0001$, $p = 0.9271$) after a mature gait pattern is established at around 5 years of age. Femur midshaft shape, on the other hand, changes significantly with age throughout the growth process ($r^2 = 0.3983$, $p < 0.0001$). During growth, both femur midshaft dimensions (AP and ML) show a significant positive correlation with growth in length and head diameter. The squared correlation between midshaft AP diameter and length is 0.8064 ($p < 0.0001$) and the r^2 for midshaft ML diameter and length is 0.6978 ($p < 0.0001$). The relationship (r^2) between femur head diameter and midshaft AP and ML dimensions is 0.7772 ($p < 0.0001$) and 0.7687 ($p < 0.0001$), respectively. However, after controlling for growth in length, head diameter does not significantly ($p = 0.1038$) contribute to the variation in AP diameter. Conversely, growth in length does not make a unique contribution to the ML diameter ($p = 0.6529$) above that shared by head diameter.

These results suggest that changes in the midshaft AP diameter during growth are primarily associated with changes in femur length (i.e., stature) and changes in the ML dimension are mainly related to femur head diameter, which reflects body build. The non-significant secular change in the midshaft AP dimension among adults is most likely due to increases in femur length counteracting the changes expected due to decreases in activity levels. The significant negative secular change in midshaft ML diameter, on the other hand, reflects a decrease in activity combined with the retention of a relatively constant body build over the past 140 years. Thus, changes in the ML dimension are more indicative of the level of mechanical loading of the femur in modern Americans. In general, the femur morphology of modern Americans reflects the combination of changes in stature, body build, and activity level that have taken place over the past one and a half centuries. Since most methods for estimating sex, ancestry, and stature from the femur are based on nineteenth century skeletal collections, it is crucial that forensic anthropologists understand how these secular changes may affect the interpretation of today’s forensic cases.

Forensic Anthropology, Secular Change, Femur

H66 SIRLI (Sistema de Identificación de Restos y Localización de Individuos): A Review of the First Year of Mexico's Database for Missing Persons

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After attending this presentation, attendees will be aware of the formation and progress of a new database established to help identify undocumented immigrants that perish crossing the U.S./Mexico border. Attendees will be provided with instructions for submitting cases to the database for assistance with identification.

This presentation will impact the forensic community and/or humanity by providing details of the establishment of an internationally functional database that will facilitate the identification of deceased undocumented Mexican immigrants to the U.S.

Each year the Secretaría de Relaciones Exteriores (SRE) of Mexico receives roughly 5,500 requests from Mexican citizens soliciting support to locate relatives missing in the U.S. The current Mexican population residing in the U.S. is estimated between 10 and 11 million which makes these inquiries difficult to resolve. To compound this problem, it is estimated that more than one million individuals pass undocumented from Mexico into the U.S. each year. Due to a tightening of border security that began in the 1990s, undocumented entry into the U.S. is confined to areas of desolate, inhospitable terrain. As a result, many illegal entrants die along the 2,000 mile U.S./Mexico border and their remains are often not found for weeks or months if at all. In 2005, the U.S. Border Patrol recorded more than 500 deaths along the southern border with Mexico with more than half of those bodies found in Arizona.

In 2005, the SRE launched an ambitious new database, System for the Identification of Remains and Localization of Individuals or SIRLI, in an attempt to facilitate efforts of locating the missing Mexican citizens both living and deceased. The SIRLI database was created by Image Ware Systems, a U.S. identity management firm. SIRLI incorporates information from missing-persons reports that can be filed by families in SRE offices both in Mexico and the U.S. The next phase of the project will allow individuals to file reports directly to SIRLI using a web-based interface. The information reported includes demographic information such as name, age, sex, known addresses in both Mexico and the United States, exit point from Mexico into the United States. In addition, photographs of the missing person as well as of scars or tattoos can be scanned into the system and viewed by officials at any of the 45 U.S. consulates or SRE offices in Mexico in order to make comparisons. Image Ware also incorporates facial recognition software that compares these images to those taken from deceased individuals. Fingerprint data along with signature information taken from Mexican voting cards, military and consular registries are entered into the database. Lastly, the database includes a section for the storage and comparison genetic data for both mitochondrial DNA (mtDNA) sequence analysis and STR loci.

Currently mtDNA analysis is being performed at Baylor University on a subset of unidentified remains believed to be from undocumented immigrants as well as for individuals that have been tentatively identified using other means. To date, Baylor has received 158 bone samples and one hair sample from deceased immigrant remains and 37 blood samples from living relatives of the missing.

There have been twenty-six mtDNA matches made between bone samples and maternal relatives of the missing. The combined efforts of the U.S. medical examiner's offices, Mexican consular offices, border patrol and local officials have been facilitated by this new depository of information focused primarily on individuals migrating from Mexico to the United States. SIRLI has provided a much needed tool to enhance communication and availability of information to those entrenched in identification efforts. In the future, Mexico's SIRLI database can be used

as a template for similar databases that are needed in other countries around the world.

The Mexican government provides these services free to all Mexican citizens and immigrants who begin a search by contacting a Mexican consul office in Mexico or in the U.S. Forensic scientists are encouraged to contact the nearest Mexican consulate office when faced with a potential undocumented immigrant so that the case be included in SIRLI.

This paper is dedicated to Dr. Richard L. Jantz who's philosophy "...you can never have too much data" has inspired generations.

Database, Migrant Deaths, mtDNA

H67 An Argument for the Increased Involvement of Forensic Anthropologists in Mass Fatality Incidents in the United States, United Kingdom and Europe

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After attending this presentation, attendees will gain a clearer understanding of the role of forensic anthropologists in mass fatality incidents and the importance of having forensic anthropologists on national DVI teams, federal DMORT teams and private companies involved in mass disaster management.

This presentation will have an impact on the global community with regards to the role and use of forensic anthropologists in mass disasters. This presentation will impact the forensic community and/or humanity by looking at the comparison and contrasting role of forensic anthropologists in the U.S., UK, and Europe.

In any disaster, there is always an outpouring of forensic professionals prepared to go into a disaster to recover the remains, conduct postmortem examinations and identify the victims to ensure their return to the families. These 'standard' forensic identification teams include the usual specialties like Forensic Odontology, Forensic Pathology and DNA specialists. However, forensic anthropologists, depending upon the geographical location of the disaster, are not always called upon or utilized to assist in the recovery and identification process of victims.

In the United Kingdom (UK), the role of the forensic anthropologist in a mass disaster is limited. The UK depends upon its national Disaster Victim Identification (DVI) teams which are staffed mainly by police officers. Forensic anthropologists are only called upon when requested but are not specifically attached to any particular team. In contrast, the federal Disaster Mortuary Operational Response Team (DMORT) teams or private companies like Kenyon International Emergency Services, Inc. retain forensic anthropologists on a contractual basis as part of the forensic identification teams in the United States.

Globally, disasters like aviation crashes, hurricanes and tsunamis kill hundreds of people of all ages, races and ethnic backgrounds. A forensic anthropologist is trained to examine the minutest fragment of bone and develop a biological profile in order to help in the confirmation of positive identification. It is essential that a forensic anthropologist be part of the team in order to process the fragmentation of bones.

The science of forensic anthropology is a proven, essential and required discipline in a mass fatality incident. In today's society there is a moral and ethical responsibility to provide all resources and technology needed to identify an individual following a disaster no matter how large or small. Forensic anthropology must be a recognized and required discipline not only in the U.S. and UK, but in all countries that deploy DVI teams or forensic identification teams during a mass fatality disaster.

Mass Disaster, Mass Fatality Incident, Forensic Anthropology

H68 Introducing Forensic Anthropology to Albania Using the Problem-Based Learning Model

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After attending this presentation, attendees will learn the basic concepts of the problem-based learning model and appreciate its efficacy in teaching forensic anthropology, particularly in an international course of relatively short duration in which proactive and cooperative group dynamics are critical components for success.

This presentation will impact the forensic community and/or humanity by raising awareness of the benefits of the problem-based learning model amongst forensic science educators, particularly anthropologists.

This presentation describes the use of the problem-based learning model to teach forensic anthropology in an international field school setting at Butrint National Park in Albania, a country with no history of academic programs in physical anthropology.

Attendees of this presentation will learn the basic concepts of the problem-based learning model and appreciate its efficacy in teaching forensic anthropology, particularly in an international course of relatively short duration in which proactive and cooperative group dynamics are critical components for success.

Problem-based learning (PBL) is a method of teaching that uses actual and hypothetical cases, individual research, and group discussion to foster more effective acquisition of skills and knowledge by students than the traditional lecture format. The typical classroom interaction between professors and students is generally static and passive; in contrast, PBL creates a proactive, student-centered learning environment that provides students with extraordinary analytical and problem-solving skills. In use since the 1980s at many medical schools including Harvard, Bowman Gray, McMaster, and Michigan State, PBL is particularly suited for teaching the forensic sciences with their combination of conceptual, analytical, and psychomotor elements. Perhaps without realizing it, forensic anthropologists use the PBL method when they assign their students a skeleton to analyze as part of their osteology and forensic anthropology courses. Yet an extensive review of the forensic science literature reveals few papers that even mention the approach and none associated with forensic anthropology.

PBL creates a dialogue between the process of learning and the content that is required of the discipline's practitioners. Rather than simply providing answers to student questions, in PBL the professor identifies the relevant learning issues associated with the case, facilitates student research using textbooks, online sources, and interviews with appropriate experts; and guides the student group discussions. Students actively contribute to and share in their own learning process, initially by defining additional learning objectives and then by collecting appropriate information and critically evaluating their own performance and that of their peers. This collaborative process provides immediate feedback both within and outside of the group discussions, encouraging and reinforcing positive behavior and interpersonal communication. Faculty and students who participate in PBL-based programs report higher levels of satisfaction with their educational experience and more effective performance in clinical and other "real-life" settings that require analytical thinking and problem solving after graduation.

Both PBL and physical anthropology are foreign to Albania, a country isolated from the rest of the western world from 1946 until its democratic revolution in 1991. Albania has produced only one physical anthropologist – Dr. Aleksandër Dhima – who received his graduate education in China. At present, no Albanian university offers any courses in physical anthropology.

Since 2004, Utica College has offered a four-week, six-credit forensic anthropology field school at Butrint National Park in

southwestern Albania. Butrint is a UNESCO World Heritage Site with a 3,000-year history of occupation by numerous peoples, flourishing under the Greek and Romans and again during the medieval period. Using human remains excavated at the site, participants in the field school learn the basics of forensic anthropology while immersed in a culturally stimulating environment. PBL exercises include sorting commingled remains, determining demographic profiles for each individual, identifying evidence of disease, trauma, and activity-related biomechanical stress, and reporting results in a concise, professional manner. Over the past three summers, 33 students from eight different American and Canadian colleges have participated in the course, together with six Albanians. Dr. Dhima collaborated as a consultant and professor for the course in 2004 and 2005.

PBL is especially effective for teaching this course, with its emphasis on group process and case-based discussions. This approach promotes cooperative interactions among the course's American and Albanian students, quickly bridging the language barriers and cultural gaps that initially exist. While those field school students with some previous training in osteology and forensic anthropological methods benefit the most from the PBL exercises used in the course, novices more quickly grasp the basic content of the field and are prepared for further independent investigation after the course ends.

Albania, Problem-Based Learning, Forensic Anthropology

H69 The Importance of Archaeological Site Formation Processes and Flexible Excavation Strategies to the Development of Successful Medicolegal Approaches to Mass Graves Excavation: Al Hatra, Iraq

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After attending this presentation, attendees will learn to recognize some of the pitfalls of generic approaches to mass graves work, particularly with regards to practical issues of site assessment, recovery methodology, data processing, staffing, and evidence handling. Attendees will also recognize the importance of considering historical, sociocultural, political, and environmental aspects of the mass grave(s) and the funding authorities' goals prior to devising a scope of work.

This presentation will impact the forensic community and/or humanity by providing a discussion of key considerations when devising an ethical and efficient investigation/excavation/analysis plan for mass graves.

A number of authors have presented general guidelines to mass graves excavation and monitoring techniques, primarily based on experience in the former Yugoslavia, Rwanda, Guatemala, and Honduras. While these guidelines provide valuable experience-based approaches to mass graves excavation, they are quite general in nature. This may have the unwanted effect of implying that "one size fits all," leading the less experienced investigator to ignore crucial aspects of site formation and data analysis, preventing adequate planning. In this paper, the authors will point out two vital and sometimes overlooked aspects of successful mass graves investigation and excavation: (1) the sociocultural and political history of the region, and (2) the goal of the investigation or excavation. Examples from a mass graves site near Al Hatra, Iraq, will be provided.

The goal of mass graves excavations varies geographically and temporally and can be strongly influenced by the entity providing funding. The object of excavation may range from individual identification and repatriation of remains to collection of evidence for use in the prosecution of war crimes. Numerous characteristics specific to the project in question (including the region's political and social history, site formation

processes, and goals of the perpetrators) may be factors in achieving these goals.

Individual identification requires dedicated funds and staff for mtDNA sample and family reference sample collection, public records searches (ID cards, etc.), witness and family interviews, collection of antemortem dental records and medical/dental x-rays, genealogy, and short- and/or long-term storage. This aim also requires careful consideration of cultural practices, such as settlement patterns. While mtDNA can provide valuable data regarding identity in many situations, its use in a matrilineal society is complicated by the associated reduction of mitochondrial lineage variability, particularly in cases where a mass grave consists entirely of victims from a single village. Furthermore, the presence of members of the victims' families as observers or members of the persecuted population as excavators presents significant risk of contamination. A primary goal of prosecution requires different planning strategies for long-term storage, reburial, or memorial design/dedication, as well as a focus on incident reconstruction and site formation processes. For example, the presence of multiple graves from several temporally distinct events, such as those seen in the Al Hatra area, may be important to prosecution if the aim is to prove deliberate, well-planned episodic genocide. Cause of death may be an important piece of information for prosecution, potentially requiring the involvement of forensic pathologists, ballistics experts, and the like.

The goals of the perpetrators are also important considerations for investigators, particularly where prosecution is a primary goal. Genocide patterns may range from torture and a high degree of military force and coercion (as in the former Yugoslavia) to minimum-effort-maximum-efficiency styles of execution accompanied by deceit (as in the Al Hatra area), and these patterns will be reflected in trauma patterns and the disposition of remains. These patterns are influenced by the political, social, or religious agendas of the regimes and, to some degree, the personal dispositions of the individuals responsible for carrying out the executions. Choice of weapons, demography of the victims, and morphology of the grave may provide important clues about these goals and agendas and may strongly influence recovery methods.

Mass Graves, Excavation, Iraq

H70 Creating a Standardized Approach to Capacity Building Programs in Forensic Anthropology: Human Rights Investigations in Colombia

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The goal of this presentation is to present a study that focuses on determining needs for investigative teams in nations that have a history of large scale human rights violations. The audience will gain an understanding of four areas:

1. The training needs assessment process conducted by the trainers and trainees.
2. The construction and content of the training course established by ICITAP in Colombia.
3. The evaluation of the training program's success by the trainers and the trainees.
4. The long term prospects for this type of training and the implications for Colombia's changing legal system.

This presentation will impact the forensic community and/or humanity by explaining a new approach to forensic capacity-building programs in an anthropological context.

The U.S. Department of Justice's International Criminal Investigation Training Assistance Program (ICITAP) and the US Department of Defense's Central Identification Laboratory (CIL) are collaborating in the construction and implementation of a training and capacity building program for forensic anthropology in Colombia that focuses upon forensic archeology and recovery techniques. The program's objectives are to enhance the existing capabilities of the Colombian government's human rights teams to effectively identify, process, and recover evidence from the clandestine disposal sites of individuals killed by extra-judicial executions. Built into the original design of this program is an assessment strategy allowing ICITAP and CIL to evaluate the performance of the trainers, the learning success rate of the trainees and the long term impact of this capacity building program on the trainees' day-to-day investigative practices.

The Colombian government is transitioning from an inquisitorial to an adversarial legal system and ICITAP is providing technical guidance, training and supplies to support the transition. Recently, the Colombian government has established a new initiative, the Justice and Peace Initiative, which has allowed human rights investigators and law-enforcement agencies to obtain new information about a series of mass graves in Colombia. The Colombian government wishes to prosecute the perpetrators of these crimes. To support this aim ICITAP has formulated a new training program with technical expertise provided by the CIL.

After an initial assessment of the Colombian human rights team's current operating standards for the investigation of clandestine graves, ICITAP and CIL formulated a comprehensive training program. The assessment was conducted through a direct visit to laboratory facilities in May of 2006 and a desktop review of working practices and case reporting. As a result of this assessment ICITAP and CIL identified the need for a program of textually and graphically supported, lecture and practical based training designed to impart the critical skills and theoretical foundations necessary to conduct forensic recovery of subterranean crime scenes and surface scatters of human remains. The primary aim of the training was to teach a structured and team based methodological framework, incorporating specific recovery skills and techniques.

The course incorporated field and practical classroom exercises designed to demonstrate and develop skills in the following critical areas:

- Site formation processes
- Site disturbance processes
- Taphonomy
- Stratigraphic interpretation of a site
- Excavation and recovery methodologies
- Site recording, documentation and survey
- Evidence identification, handling and management
- Chain of custody
- Long term curation and storage of evidence

The course is designed to impart these skills so that they are implemented by trainees to best support criminal justice and the identification of victims. Furthermore the course is structured so that, in the future, trainees can become trainers.

The performance evaluation procedure built into this program is tri-stage:

Stage 1: Defining desired impacts and outcomes from the training by both the trainers and the trainees.

Stage 2: Assessment of the training's initial value by the trainers, trainees and independent observers (through videotape of the training sessions) at the time of the training.

Stage 3: Assessment of the training's actual impact on forensic anthropology in Colombia.

At the time of the presentation the evaluation will be between Stage 2 and Stage 3. A detailed outline of the training program and the results of the second stage of the performance evaluation will be presented.

Although the ICITAP and CIL training program is initially focused on the current specific needs of the Colombian government, it is intended to ultimately be used to support other nations that request technical training for the investigation of large scale human rights atrocities.

Capacity-building, Human Rights, Forensic Anthropology

H71 The Current and Potential Role of Forensic Anthropology in Cambodia

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After attending this presentation, attendees will become familiarized with the potential role of forensic anthropologists in investigating human rights violations committed in Cambodia during the period of the Khmer Rouge regime.

This presentation will impact the forensic community and/or humanity by highlighting the role that forensic anthropological research can play in Cambodia, despite a number of challenges that make this area unique from other geographical locations.

From April 1975 to January 1979, Cambodia was taken over by a radical faction of communists known as the Khmer Rouge (KR). This regime sought to transform the entire population of the country into rural peasant farmers, and to this end, they relocated vast portions of the country's urban population into collective farming communities. As part of the take over, and continuing throughout their rule, the KR regime particularly targeted certain members of society such as intellectuals, former government officials, and social elites for harsh treatment and often execution; however, men, women, and children from all walks of life were potential targets for persecution. By the time the KR's rule in Cambodia ended, approximately 1.5 million Cambodians were dead from execution, ruthless forced work conditions, disease, and starvation.

In the decades since the dismantling of the KR regime, there has been much discussion about prosecuting the KR leaders most responsible for atrocities. Largely because of complicated domestic and international politics, it was not until the late 1990s that the possibility of trials became a realistic expectation. International tribunals similar to those established for Rwanda and the former Yugoslavia have yet to be realized, despite continuing efforts at negotiation between the United Nations, the Cambodian government, and other international representatives.

Forensic anthropologists have, to date, conducted limited work towards investigating human rights violations dating to the mid-to-late 1970s in Cambodia. Research has focused on identifying locations of mass graves and analyzing patterns of trauma on previously exhumed skeletal remains. Forensic anthropological research in Cambodia has been limited for a number of reasons. First, there has been little demand for the collection of forensic evidence because of the slow-moving negotiations for criminal tribunals. Second, some exceptionally damning evidence has come from the KR's own records, which include documents detailing torture and execution; therefore, evidence collected from skeletal remains might not be considered as crucial as it would be in the absence of written sources of data. Finally, for a variety of reasons the goal of individual identification of skeletal remains is, in most cases, unrealistic.

Nevertheless, forensic anthropologists have the potential to play an important role in Cambodia. Forensic investigation of mass graves and previously exhumed skeletal material has added detail to an historical record that is only partially being filled out by memoirs, witness testimony, and Khmer Rouge documents. As the flow of foreign tourists to Cambodia continues to expand, forensic anthropologists can play a valuable role in improving the education of the international public about this part of the history of Cambodia. For example, two of the most popular destinations for visitors in Phnom Penh are the Tuol Sleng museum and the Choeung Ek memorial stupa. Forensic anthropologists have played a

small role in improving and refining interpretive displays in both locations, but a great deal more work can be done, particularly, in the case of Choeung Ek, where poor curation conditions are endangering the preservation of human remains, and a detailed interpretative display is sorely needed.

Forensic anthropologists can go a long way in helping to describe human rights violations that occurred in Cambodia during 1975-1979, even if there is limited opportunity to identify victims and prosecute perpetrators. The potential role they can play in the improvement and refinement of public education should not be overlooked, and the value of such education should not be underrated.

Forensic Anthropology, Cambodia, Human Rights Violations

H72 Grave Problems in Iraq

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After attending this presentation, attendees will learn about the seldom talked about forensic work related to mass graves that has been performed to date in Iraq, about challenges in international forensic work and what must change for this type of work to be more effective.

This presentation will impact the forensic community and/or humanity by initiating discussion and cooperation amongst seemingly competing individuals and organizations towards unified international forensic assistance. It is also hoped that international protocols and operating procedures towards mass grave investigations will be developed.

International forensic work is a growing phenomenon- for investigations of international law violations and as a response to mass fatality incidents and mass disasters. The field and practice have continued to evolve, with anthropology and archaeology often playing a primary role, but several key problems persist. These have been seen in the ex-Yugoslavia but now affect work in Iraq. This presentation will be a brief review of what has been done, what is being done and what can be done related to forensic investigations of clandestine, largely mass, graves in Iraq and the examination and potential identification of those exhumed from them.

A primary problem with work thus far is that there is no 'international' infrastructure to support the work. There are no set rules, regulations, standard operating procedures or protocols. There is mission overlap between organizations which results in wasted resources, miscommunication, gaps in authority and confusion over liaison with families and governments. A good example of this was seen in Kosovo where the same forensic site was 'processed' by three different forensic teams over a period of two years. Many authors have talked about international standards, but despite all the rhetoric, the source and substance of such standards is unpublished and subjective at best.

Iraq has mimicked Kosovo to a degree in that many different groups, (e.g., Coalition Provisional Authority teams, Inforce [a UK-based forensic charity], Archaeologists for Human Rights, a Kuwaiti forensic team, The U.S. Armed Forces Institute for Pathology, the US government's Regime Crimes Liaison Office [RCLLO], International Commission for Missing Persons [ICMP], Physicians for Human Rights) have all had a hand in some or all of site surveys/assessments, training of and liaison with Iraqis and field and laboratory operations. This is not to mention the many Iraqi non-governmental teams and personnel and Kurdish teams that have been involved in investigations and excavations of clandestine graves, with or without the knowledge and coordination of the Iraqi federal government and/or U.S. authorities in Iraq. The scale of multiple organizational efforts is unprecedented and given the lack of centralized authority, perhaps impossible to coordinate.

Taken further, different organizations are often found to behave as if they are in competition with one another. This is not unique to Iraq, of course, and can be seen at local and national levels in many places, including the United States. However, this results in lack of transparency, professional disagreements that can develop into lawsuits, and confusion for the survivors of crimes, all of which negatively affect the primary objectives of the work: the needs and concerns of the families and communities of the victims and their interests in a process of justice, identification, repatriation and the advancement of scientific knowledge via the experience.

Another problem being seen in international forensic work is that of paradigm. There is a harmful discussion in the literature of a dichotomy of 'forensic' versus 'humanitarian' work. Experience of collaboration between ICTY (the International Criminal Tribunal for the ex-Yugoslavia) and ICMP, in the ex-Yugoslavia has shown that organizations can work on sites together to accomplish seemingly independent primary objectives, despite the obvious overlap in aims of evidence collection (ICTY) and identification (ICMP). Latin American teams have demonstrated that serving both the so-called humanitarian interests of families (e.g., individual identification and repatriation) and the evidentiary requirements of courts can be accomplished by a single organization.

The most significant challenge for grave investigations in Iraq is obviously security and there is little that forensic practitioners can do about it. Nevertheless, the professional community should be prepared to assist the Iraqis when the time of safe and wide-scale investigations comes. International standards and operating procedures should be widely discussed, developed, published and distributed. Organizations and professionals must recognize that victims of war crimes or other grave violations of human rights, which include survivors such as family and community members of those killed, will only suffer more with a lack of organized and coordinated efforts.

Osteoarchaeology, Iraq, Mass Graves

H73 Differential Diagnosis of Torture in Skeletal Remains

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After attending this presentation, attendees will understand how to recognize patterns of skeletal injuries consistent with torture as observed in cases of human rights abuses. Further, participants will learn key aspects of blunt force injuries to the skeleton and how to differentiate such injuries from other mechanisms of trauma or postmortem damage.

This presentation will impact the forensic community and/or humanity by illustrating how forensic anthropology is an important tool in the enforcement of human rights. This study presents cases of documented torture and the roles legal-medicine and anthropology play in documenting these types of cases and presenting patterns of abuse in international criminal trials.

According to the United Nations General Assembly resolution 39/46 (entered into force 1987), Article 27(1) of the *Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment*: "the term "torture" means any act by which severe pain or suffering, whether physical or mental, is intentionally inflicted on a person for such purposes as obtaining from him or a third person information or a confession... when such pain or suffering is inflicted by or at the instigation of or with the consent or acquiescence of a public official or other person acting in an official capacity..."

During the years 1980-2000, more than 65,000 Peruvians lost their lives due to the armed conflicts between national security forces and the two guerrilla organizations, Sendero Luminoso and the Movimiento Revolucionario Tupac Amaru (MRTA). In 1998, Peruvian Law No. 26926

criminalized torture and since then, three cases of torture have resulted in convictions. Currently, there are 118 reported cases of torture and 56 deaths in military barracks in Peru. Current estimates point to over 11,000 people missing as consequence of the armed conflict in Peru. The Peruvian Forensic Anthropology Team (EPAF) is currently working to determine the whereabouts of the Missing, investigate these deaths, exhume graves, identify and return the remains to their families and collect forensic evidence to be used in criminal trials.

Since the first conviction of torture by the International Criminal Tribunal for the former Yugoslavia (November 30 2005) using forensic evidence (Limaj et.al IT-03-66), four cases of documented torture with evidence of skeletal injuries have been investigated by EPAF in Peru. A group of four other cases of suspected torture were also investigated. In these cases, cruel treatment was suspected; however, there was no witness testimony available to corroborate the findings. To complete a differential diagnosis and assess whether the injuries in these latter cases were consistent with patterns of abuse and torture, it was compared to the four documented cases involving torture and to another unrelated case, which resulted in similar injuries but from a different mechanism (blunt force trauma to the chest due to a traffic accident). All eight cases shared specific and diffuse traumatic injuries in the thoracic cage characterized by linear fractures on ribs and/or the sternum located on the anterior, lateral and posterior aspects.

In the four known cases of torture, survivors provided witness testimony of the incidents. These witnesses stated that inhumane and cruel treatment was inflicted prior to the deaths of the victims, including the victims being stomped, kicked, and hit prior to being killed. The two types of injuries observed included antero-posterior compression of the chest characterized by fractures adjacent to the costochondral cartilage, and isolated and paired fractures in other various regions of the chest, likely resulting from direct impact.

Differential diagnosis of the injuries sustained in cases of torture compared to a traffic accident, show that in the latter, injuries were consistent with an acceleration/deceleration mechanism. Therefore the pattern of injuries resulting from abuse was markedly different than a traffic accident. Further, the pattern of injuries observed in the torture cases was consistent with the witnesses' testimony in which it is described how injuries were inflicted.

Medico-legal investigations into human rights abuses must be focused on the types of trauma that may be inflicted to people prior to death. A detailed analysis of the wounds includes the locations, morphology, and frequency of wounds. These variables enable a differential diagnosis and estimation of the mechanism of injury and are discussed in this paper. It is concluded that in cases of human rights violations, thoracic trauma such as fractures to the ribs, sternum and spine, are good indicators of torture in cases that may or may not have circumstantial or testimonial evidence. This analysis demonstrates how a differential diagnosis can accurately estimate injuries caused by torture from those caused by other mechanisms, even in cases with a different manner of death.

Torture, Human Rights, Blunt Force Trauma

H74 Blasting Injuries in Human Rights Cases and Armed Conflicts

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After attending this presentation, attendees will understand the prevalence of blasting injuries in cases of human rights abuses and armed conflicts. Participants will learn how to differentiate blasting injuries from other mechanisms of injury such as gunfire.

This presentation will impact the forensic community and/or humanity by demonstrating the types of injuries commonly encountered in human rights investigations and differential diagnosis for blasting injuries. This will serve as a useful tool for pathologists and anthropologists when estimating the most probable cause of death.

Anthropologists and pathologists work together to reconstruct skeletal injuries and establish the most probable cause of death in cases of human rights violations and armed conflicts. Victims of modern conflicts often suffer multiple injuries, from conventional weapons including gunfire and blasting injuries (i.e., landmines, grenades, bombs, and mortars). Civilian and military targets differ in the prevalence of various injury mechanisms. When civilians are the intended target of violence, it is not uncommon for individuals to suffer multiple injuries from various mechanisms, with wounds prevalent throughout multiple regions of the body and from a variety of trajectories. Additionally, in attempts to hide the remains and crimes committed, deceased bodies are commonly blown-up, burned, thrown off bridges or cliffs, and even buried/exhumed and later re-interred multiple times to hide the location of the grave. Each of these processes leaves a mark on skeletal remains. Distinguishing injuries, taphonomic alterations, and post-mortem fractures for each victim is a routine part of the post-mortem examination and is paramount for accurately diagnosing each mechanism of alteration.

Characteristically, blasting injuries result in multiple victims from a single incident and injuries that are widespread throughout the body, affecting multiple anatomical systems. The factors that affect the wound morphology include the type of explosive, the range of materials used to construct blast and shrapnel, the location of the explosions within a structure or outside of a structure, the total amount of materials used in the construction of the explosive, location of the victim relative to the blast, and the presence of an intermediate target between the victim and the blast. Therefore, there is a wide range of variation observed among blasting injuries.

Injuries from low-order explosives result from the “blast wind” and may include wounds from fragmented shrapnel or thermal injuries. In cases of high-order explosives, injuries result from the over-pressurization “blast wave” force. The three mechanisms of high-order explosive injuries that may affect the skeletal system are characterized as Secondary, Tertiary, or Quaternary injuries. Wounds result from penetrating shrapnel or fragmented bomb components, blunt force compression or crushing injuries from flying debris, bone fractures result from the individual being thrown from the blast or hit by a secondary flying object, or the traumatic amputation of limbs. High-order explosives tend to be military issued or “manufactured.” These types of blasts cause injuries that are different from “impoverished” explosive devices where an object is modified from its intended function and made into an explosive device. “Impoverished” devices may include scrap metal or metal objects such as household utensils that are cut into pieces and used as shrapnel in grenades or bombs.

This study reviews cases of blasting injuries among civilian targets that resulted during armed conflicts investigated by the United Nations, International Criminal Tribunal for Former Yugoslavia in Kosovo (1998) and Bosnia-Herzegovina (1991-1995) and current cases investigated by the United Nations, Office on Missing Persons and Forensics in Kosovo. This study highlights methodology for differential diagnosis of wounds produced by shrapnel from high-order explosives from gunfire projectiles. A differential diagnosis may be possible based on the number, location, pattern of wounds and wound morphology. This paper presents cases to demonstrate how the projectile tracks, the number and sequence of multiple injuries, and the direction/location of the blast may be estimated. This study investigates variation in wound morphology resulting from differences between “Manufactured” and “Impoverished” explosive devices. Finally, important trends in the demographic pattern of victims who incur these types of injuries, as relevant to criminal cases of violations to international humanitarian law, are discussed.

Blast Injury, Blunt Force Trauma, Armed Conflicts

H75 Decomposition in a Mass Grave and the Implications for Post Mortem Interval Estimates

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After attending this presentation, attendees will understand the processes that create the unique decomposition pattern observed in mass burials and how they differ from single burials as well as information regarding the effect that disturbance has on decomposition within burials.

This presentation will impact the forensic community and/or humanity by demonstrating information that aids in estimating with greater accuracy post mortem intervals from mass burials.

The identification of human remains and estimation of post mortem interval (PMI) are very important in any forensic case. In the investigation of mass graves complications arise, as decomposition within a mass burial does not follow the same pattern as a single burial. Individuals within a mass burial have been anecdotally noted to decompose at different rates depending on where they are positioned within the mass (Haglund 2002). This introduces error into standard PMI estimation methods. Currently, the variables involved in this phenomenon and the resulting deviation from predicted decomposition patterns have not been understood or researched.

The experimental research was undertaken at Newton Rigg, Penrith, UK for 70 days. In accordance with DEFRA regulations, rabbit carcasses obtained from standard pest control measures were buried, and examined at varying intervals. The study compared decomposition patterns between and within mass graves as well as between mass and single graves. Twenty-five rabbit carcasses were buried within two mass burials of nine each, and seven single burials. Carcass weight, carcass temperature, soil temperature (at both centre and periphery of the mass graves) and soil pH data were collected throughout the study and decomposition scores were assigned to each carcass. Disturbed and undisturbed burials were used to compare the effects disturbance had on subsequent analyses. One mass grave was exhumed and observed every 10 days; the other mass grave was exhumed only on day 70. One single burial was exhumed every 10 days providing controls.

Results confirm the anecdotal evidence that bodies on the periphery of a mass grave decompose at a faster rate than those in the central mass. Preliminary results indicate that these peripheral bodies also decompose at a somewhat faster rate than singly buried individuals; in contrast, the decomposition rate of the centrally located bodies compares favorably with that of singly buried remains. Disturbance does appear to affect the rate of decomposition, as decomposition was at an earlier stage in the undisturbed burial and insect activity was notably greater in the disturbed burial where flies had access to the carcasses every ten days during their exhumation for data collection purposes. The rise in pH levels for both single and mass graves closely follows that predicted by Vass et al (1992).

Mass Graves, Taphonomy, Disturbance

H76 The Decomposition of Human Remains Recovered From the River Clyde, Scotland: A Comparative Study of UK Fluvial Systems

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The goal of this presentation is to aid investigators when faced with a case that involves human remains recovered from a river system. Postmortem timetables and equations could be used in cases to estimate the post-mortem submersion interval more accurately and investigator will

enhance their understanding of the factors that most affect decomposition in fluvial environments.

This presentation will impact the forensic community and/or humanity by enabling the investigating authorities to more accurately predict the postmortem submersion interval. By looking at drift trajectories and the timing of resurfacing events, parties involved in search and recovery may be able to narrow down their search area. The factors that have the greatest influence on decomposition will also be highlighted so that members of the forensic community can consider the unique effects each specific river may have on the rate and sequence of decomposition and its effects on the investigation.

Each year thousands of bodies are deposited in aquatic environments for a variety of reasons, yet, despite widespread acceptance that the process differs from that of terrestrial processes, there is a distinct lack of systematic research timetabling decomposition in water environments. In a lotic system, a body can be transported great distances from its point of entry and this, combined with the effects of decomposition, makes identification of the individual and the circumstances surrounding their death hard to determine. The aim of this study is to increase the accuracy in estimating the post-mortem submersion interval for bodies recovered from river systems in the UK.

Data was collected through the examination of autopsy reports carried out at the University of Glasgow on bodies recovered from the Clyde, Scotland, over a 15 year period (1991-2006). The study sample was composed of 135 cases (104 males and 31 females) and covered an age range of 5-84 years. For each case, the body was divided into two areas, the head and the torso (including the limbs) and each area was scored using a modification of the Megyesi, et al. (2005) scale. The decomposition score is dependent on the advancement of progressive post-mortem modifications, including bloating, marbling, skin slippage and adipocere formation. These scores make it possible to produce a post-mortem timetable identifying the various stages of decomposition, the sequence in which they occur and their duration. Post-mortem timetables can be established by using the post-mortem submersion interval (PMSI) and accumulative degree days (ADD). It can also be determined which environmental or human variables affect the rate and sequence of decomposition.

Statistical analyses indicate that certain variables affect the decomposition process more than others. The scoring systems developed using data from the Clyde will be compared to similar scoring systems developed for the Thames (Brewer 2005). The results should not only allow the authors to more accurately estimate PMSI for bodies recovered from rivers, but also provide an indication as to whether the process varies between individual river systems which differ in physical, chemical and biological properties, or whether a single decompositional timetable can be applied to all UK Rivers.

Decomposition, Rivers, PMSI

H77 The Boy in the Chimney: A Case Study in Human Decomposition

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After attending this presentation, attendees will have a better understanding of human decomposition patterns in an unusual environment.

This presentation will impact the forensic community and/or humanity by providing a better understanding of the decomposition process in a residential chimney which is a somewhat unusual environment.

Human remains were recovered by the Los Angeles County Department of Coroner (LACDOC) in March 2005 from a standard residential chimney in Los Angeles, California. The property was an abandoned juvenile "halfway house" facility, vacant for a minimum of

five years (actual extent of vacancy is unknown). Due to transient activity on the property a guard is posted at the facility on a 24 hour basis.

On the date prior to recovery of the remains the child of one of the guards reported to her father that, upon her inspection from the roof, she saw a human skull within the chimney. The guard did not immediately believe the child, but upon her insistence inspected the chimney himself the next day. He saw within the pipe of the chimney what he believed to be human remains and called 911.

The external aspect of the chimney consists of an outer stone and cement structure approximately 5 feet long, 3 feet wide and extending 2 feet above the flat roof surface. The top of the stone surface is covered in concrete. The chimney pipe is clay, extending approximately 6 inches from the concrete surface, and is an oval approximately 18 inches long and 10 inches wide.

Within the building structure, the hearth is also stone and concrete, with a metal liner. The hearth measures approximately 4 feet across and 3 feet in height. The depth of the hearth box is unknown. The flue above the hearth box is also metal, and was closed at the time of discovery.

Anthropological examination of the remains showed almost complete skeletonization with some slight remaining mummified soft tissue within the clothing. Both pants and shirt remained, covering the bones. The remains retained an organic, waxy odor and organic bone "grease" was visible. The bones not covered by clothing exhibited a light coating of soot, which was easily brushed away. The clothing was also covered with soot and ash. The bone showed no evidence of charring or burning.

The decedent was determined to be male, approximately 13-17 years of age, and of African or African-American ancestry. Close examination of the skeleton revealed no evidence for either cause or manner of death. Based on the experience of the anthropologist of the normal rate of decomposition in the dry, urban environment of Los Angeles, postmortem interval was estimated at greater than one year but probably less than five years.

The Identifications section of LACDOC, along with the Los Angeles Police Department, searched through the missing person reports in an attempt to identify the decedent. Additionally, because the decedent had a distinctive combination of facial features, a two-dimensional facial reconstruction was done by a forensic artist. Local television stations featured the reconstruction and a possible identification was made, leading to a positive identification of the decedent through DNA analysis.

The decedent was identified as a 14-year-old African American male, found wearing the clothes in which he was reported missing in 1977. The extended postmortem interval shocked all LACDOC personnel involved with the case, and initiated a study of the preservation conditions in the chimney environment. The precise decomposition environment was impossible to duplicate experimentally. The halfway house was occupied over most of the almost 30 year period of slow decomposition and it is unknown how often the flue was left open vs. closed (changing the airflow patterns in the chimney), how many fires were burned during the decomposition period, the precise temperatures, amount of rainfall, or humidity within the chimney, to name only a few of the variables under consideration. However, using the average annual temperatures, rainfall and humidity, and incorporating the annual ranges of these variables, estimating few fires in the chimney (given the fact the facility was a juvenile halfway house rather than a private residence, and the fact the facility is in Southern California), considering the flue closed unless a fire was burning, and considering the time of year the decedent disappeared (December), a model of the decomposition process was constructed. The final consensus on the slow decomposition was that this chimney presented a unique set of environmental characteristics for decomposition, including low humidity, moderate temperatures, easy air flow, a porous "ground" surface (the clay chimney pipe), few insects (in December, when the boy disappeared), and enough fires to create a drying effect but insufficient dry air for complete mummification, leading to the extended decomposition period seen in this case.

Decomposition, Skeletal Remains, Chimney

H78 Patella Sex Determination by 3D Statistical Shape Models and Nonlinear Classifiers

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After attending this presentation, attendees will learn about a novel 3D statistical method to automatically sex the patella from CT scan data with a high degree of accuracy and repeatability.

This presentation will impact the forensic community and/or humanity by demonstrating how the patella is a compact bone that often survives intact in forensic contexts, yet is greatly underestimated for its role in sex determination.

Sex determination is one of the major challenges for the forensic anthropologist within a medical-legal context and is one of the essential steps in personal identification of an individual from skeletal remains. The most commonly used statistical method in analyzing this sex determination problem is discriminant function analysis. Most bones have been subjected to discriminant function analysis but not much literature has been found on the usefulness of measurements of the patella in the determination of sex using this method. This paper proposes a new sex determination method from patellae using a novel automated feature extraction technique. A dataset of 228 patellae (95 females and 133 males) was collected from the William M. Bass Donated Collection of the Department of Anthropology at the University of Tennessee. High resolution CT scans were conducted using a GE Lightspeed 16 slice computed tomography scanner. After the CT data was segmented, a set of features was automatically extracted, normalized, and ranked. These features include geometric features, moments, principal axes, and principal components. A feature vector of 45 dimensions for each subject was then constructed. A set of statistical and supervised neural network classification methods, were used to classify the sex patellar vectors. Nonlinear classifiers such as neural networks have been used to analyze several medical diagnosis problems. Examples include quantitative liver tissue characterization, bladder outlet obstruction computerized diagnosis and automated chromosome classification. In this paper, different classification methods were compared and a new method for sex determination is proposed which extracts more categories of features, other than the geodesic measurements, and analyzes the classification problem in a nonlinear approach using neural networks. Following the atlas construction and alignment steps outlined above, all the patellae models now lie in the same coordinate frame and have homologous points and faces. In this coordinate frame, six points are found to be the maximum and minimum values for the coordinates x , y , and z respectively. This yields three measures of maximum mediolateral (ML) width, maximum anteroposterior (AP) depth, and superoinferior (SI) height. Additionally, the six points are used to construct a bounding box around the patella, which is used to extract three features describing bounding box width (BBML), bounding box depth (BBAP), and bounding box height (BBSI). Classification success ranged from 83.77% average classification rate with labeling using fuzzy C-Means method (FCM), to 90.3% for linear discriminant function (LDF) analysis. The authors obtained results of 96.02% and 93.51% training and testing classification rates, respectively using feed-forward backpropagation Neural Networks (NN). These promising results of the new features and the use of nonlinear classifiers encourage the usage of this method in forensic anthropology for identifying the sex from incomplete skeletons retaining at least one patella.

Patella, Sex Determination, 3D Statistical Shape

H79 The Problem-Based Learning Approach to Forensic Anthropology at Butrint National Park, Albania: The International Student Perspective.

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After attending this presentation, attendees will understand the value of a problem-based learning approach to teaching forensic anthropology and how this approach could lead to increased rate and quality of learning for students studying forensic anthropology.

This presentation will impact the forensic community and/or humanity by demonstrating from the perspective of four participating students from four different universities and three nationalities how a problem-based learning approach can be effectively applied to the study of forensic anthropology in an international field school setting.

The problem-based learning (PBL) format is finding increasing acceptance throughout all levels of education and various disciplines, including the forensic sciences. This presentation illustrates the benefits gained by four undergraduates who received the majority of their instruction through this teaching approach while attending the Utica College forensic anthropology field school in 2006 at Butrint National Park in southwestern Albania. Located near Albania's border with Greece, Butrint is a UNESCO World Heritage Site first inhabited in the 7th century BCE.

The PBL model focuses on encouraging students to use their existing knowledge and exploring pertinent references to solve a problem through group discussion and teamwork, facilitated by an instructor. In contrast to traditional didactic lectures, the approach generally involves presenting the students with a problem that requires them to use their accumulated knowledge, acquire new skills and information, and reach consensus to find the best solution. In forensic anthropology, the problem case usually involves determining the biological profile and personal identity for an unknown skeletonized individual as well as documenting the cause of death and potential postmortem insults.

During the summer of 2006, four undergraduates from four different universities in the United States and Canada participated together with nine other students in a forensic anthropology field school offered annually by Utica College at Butrint National Park. All four students had previously completed at least one undergraduate course in human osteology or forensic anthropology at their respective schools. As part of the field school experience, the four students were presented with the problem of sorting and assessing commingled human remains excavated the previous year from a medieval burial vault at Butrint. Dating from ca. 1100-1300 AD, the well-preserved remains comprised at least five adults – a single primary burial subsequently mixed with at least four others.

Employing the PBL approach, the field school instructors provided guidance but no specific instructions on how to sort and differentiate the remains of the commingled individuals. Consequently, the four students used textbooks and other sources of data to determine the sequence of procedures that were required to effectively sort the remains and reassemble the five individuals within the two-week period allowed for the exercise.

Following the case-based discussion format that underlies PBL, the instructors were available for consultation and monitored the students' progress daily. To ensure consistency and accuracy, the instructors performed all cranial and postcranial measurements that were initially taken by the students and evaluated their morphological analyses. The students used the multi-factorial approach to determine the age, sex, and ancestry of the five individuals from the vault, a task made more difficult because all five individuals were young women who had died around

20-35 years. No evidence for specific causes of death was observed. The student team documented markers of occupational stress including squatting facets as well as evidence of infection and nutritional deficiency amongst all of the individuals.

The key benefits of the PBL model for the students enrolled in this field school were the opportunities to learn and proactively employ the skills necessary for the practice of forensic anthropology in a setting where their decisions were a product of their own experiences and discussion. This approach allowed the students to concentrate in areas of their choice and to strengthen their expertise in specific aspects of forensic anthropology by actively sharing their knowledge with the others, garnering immediate feedback. It also served to foster a sense of accomplishment among the students and raise their levels of confidence in their own abilities once the separation and analyses of the remains were completed.

In summary, the PBL model ensured that the four participating international students, working together in an international setting, acquired the practical skills necessary to work effectively in a group dynamic, solve logistical difficulties quickly, and reach a consensus resolving the problem of the commingled remains from the medieval burial vault. These results indicate that use of the PBL model for teaching forensic anthropology represents an effective approach for students to learn and value the crucial elements required in mass disaster responses as well as daily forensic settings. As such, the PBL approach should be considered for use in a broader range of educational settings within forensic anthropology.

Albania, Student Perspectives, Problem-Based Learning

H80 Long Bone Ratios for the Bosnian Male Population

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After attending this presentation, attendees will understand how to use the long bone ratio method for re-association of commingled human remains in situations where there is no physical connection between the upper and lower parts of the skeleton.

This presentation will impact the forensic community and/or humanity by demonstrating procedures of examination (re-association) of commingled human remains conducted by forensic anthropologists and exhumed from primary and secondary mass graves. The method might possibly lower the cost of DNA matching for identification purposes.

The 1992-1995 war in Bosnia and Herzegovina left the country with estimated 250,000 dead, and more than 30,000 individuals were considered missing or unaccounted for as their whereabouts were not known. The majority of the exhumed individuals in Bosnia and Herzegovina represent severely commingled or incomplete skeletons, which causes great problems in the identification process in Bosnia and Herzegovina.

Human remains can become commingled as the result of natural taphonomic processes or human postmortem activities. Natural, taphonomic commingling occurs in primary gravesites, such as caves, where bones commingle as the soft tissue decomposes. Surface remains or shallow graves can also undergo commingling due to animal scavenging and dispersal by humans, vehicles, and gravitation. Man-made commingling can be the result of poor exhumation procedures, frequently compounded by the removal and transfer of remains from original graves into new graves, in an attempt to hide evidence of the crimes committed. In the latter, heavy equipment was used to remove remains from original (primary) burial sites and re-deposit them into remote new mass graves,

so-called secondary or tertiary graves. Human remains in secondary graves are severely commingled and dismembered, and body parts are often missing as bodies have been separated during removal and transportation. Presumably they could have been left behind in the original grave or deposited into one or more secondary graves.

Methods used for sorting commingled remains are mainly morphological, where bones are assembled by visual examination of morphological similarities such as the size and shape, articulation of adjacent bones, patterns of muscle attachments, and age-related changes. This morphological method can be useful for pairing bones or re-associating them with incomplete skeletons missing bones from either side of the body. However, such re-association is only possible for remains recovered from primary graves, where all unassociated bones were recovered. Since there is no morphological similarity between bones from the lower and upper extremities, the visual approach fails to be sufficient when applied to commingled remains where bones are missing and the connection between the upper and lower parts of the skeleton has been compromised. Osteometric analysis is another method used for sorting and re-association of commingled remains. It is based on using bone measurements for the entire assemblage (Byrd and Adams 2003). Osteometric methods used in the identification process in Bosnia and Herzegovina are mostly based on data from the North American population. Therefore, due to the large quantity of exhumed individuals and to the severe commingling of remains, it is important to establish population specific osteometric standards for the Bosnian population.

Long bone measurements used in this study are derived from males exhumed in Krajina, the north-west part of Bosnia, in the period 1998-2005. Comparison of lengths of right and left long bones was conducted on 150 individuals with all twelve long bone measurements, and 719 individuals with measurements for one or more of the long bone pairs. Results obtained for the upper extremity showed that all bones of the right arm are significantly longer than bones from the left arm, thus confirming the majority percentage of right handed individuals in any population. For bones of the lower extremity, left femur and left fibula were found to be significantly longer than the respective bones from the right side of the body, while left tibia is on average longer than the right tibia, although this difference was not statistically significant.

Long bone ratios were established from a sample of 1217 individuals with more than two long bones present from the left side of the body, and 878 representing bones from the right side. Additionally, regression equations were established for all long bones. The ratios for humerus/femur, humerus/tibia and tibia/femur are presented in the table below.

	Left Humerus/ Left Femur	Right Humerus/ Right Femur	Left Humerus/ Left Tibia	Right Humerus/ Right Tibia	Left Tibia/ Left Femur	Right Tibia/ Right Femur
Mean	0.717	0.721	0.877	0.881	0.817	0.819
Minimum	0.639	0.632	0.766	0.794	0.744	0.747
Maximum	0.818	0.802	0.985	0.997	0.904	0.895
Count	929	606	783	701	963	706

The use of long bone ratios in the identification and re-association process of incomplete and commingled human remains may lower the cost of DNA supported re-associations in Bosnia and Herzegovina, by narrowing down the number of DNA samples required through the process of elimination of possible matches.

Reference:

¹ Byrd, J. and Adams, B.J. 2003. Osteometric sorting of commingled human remains. *Journal of Forensic Sciences*. 48: 717-724

Identification, Commingled Remains, Bone Ratios

H81 The Mastoid Sinuses and Their Potential in Comparative Radiology for Forensic Anthropology

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After attending this presentation, attendees will gain an appreciation for establishing new and useful quantitative techniques in regards to human identification; specifically to comparative radiography of the mastoid sinuses.

This presentation will impact the forensic community and/or humanity by instilling the idea that mastoid sinuses are a practically untouched resource in widening the methods utilized for human identification.

Mastoid sinuses are an untouched resource in forensic anthropology and comparative radiology. These sinuses are presently used to aid in making a positive human identification by comparing an ante-mortem x-ray and a post-mortem x-ray. This method is trustworthy on a qualitative level but should be further pursued to enable the forensic community the ability to quantitatively compare the mastoid sinuses in relation to human identification.

This project's purpose was to look at computed tomography scans (CT) of 25 males and 27 females in the computer system they were originated from to establish a measuring technique. A quantitative system was created to measure mastoid sinuses in ante-mortem and post-mortem CT scans and means of establishing positive identification. This measuring system would show extreme variability between individuals or between males and females therein turn creating Mastoid sinuses were decided upon due to their consistency throughout life after the age of twenty, they do not alter unless afflicted by disease, their vast complexity which allows for greater amounts of research and comparison, and the fact that they are housed within one of the strongest bony areas of the body, allowing the mastoid sinuses to survive extreme situations during per-mortem events.

The CT scans of fifty-two individuals were first examined to determine if there was a way using the Seimens Computer program in the CT scanner to measure mastoid sinuses. After testing five individuals it was determined that a particular slice of two views (coronal and axial) of a CT scan would need to be established as the measuring spots for each individual tested. These views, or slices, were established by looking at a complete set of scans for the five individuals and determining that there were anatomical landmarks in each person's set of scans that were consistent. These landmarks were chosen enabling consistent slices for each individual measured in the entire project. Once these landmark slices were established a measuring system needed to be developed.

The computer program used in this project the user to make the mouse of the computer a measuring tool for irregular shapes. This enabled the users to trace with the mouse cursor the outline of each mastoid sinus, giving the area measurement. Then the user measured the length and width within the area measured around the sinus. Each measurement was taken three times, twice by the author and once by the associate researcher. Once these measurements were all gathered, they were entered into a database that was compatible with the statistics program SPSS. Descriptive statistics were utilized to demonstrate the range of measurements obtained, the ages within the sample and the differences between sexes. Initially, the author wanted to statistically compare each individual to one another to show the statistical variability between since there were no previous mastoid measurements or research exactly like this to compare against the currently gathered measurements this was not accomplished. The author then took all of the measurements and compared the largest measurement to the smallest demonstrating that there are statistically significant differences among the overall range of individuals. This test

only allows the author to show the wide range of measurements and that each individual has their own area with length and width, but not that they are significantly different measurements. This project also statistically compared the male area measurements to the female area measurements to establish if there were any statistically significant differences in measurements between sexes. Testing was also done on the correlation between various measurements. These tests were run to establish what relationships were likely and how often they may occur, enabling the researcher to expect certain results in future measurements. Inter-observer error was tested as was intra-observer error to establish if the measurement technique used was reliable.

Results indicated that the age range in this project was wide; 20 to 95 years of age. Descriptive statistics indicated that every individual had a unique area measurement. There was low correlation between age and sex indicating that age and sex did not affect the area measurement. There was a high correlation between area measurements of the right and left sides of the individual, indicating that development rates are similar and do not vary a great deal after full development of the sinuses. Lastly, length and width were highly correlated area as would be expected due to anatomical consistency between the left and right sides. Overall, this project was able to demonstrate that the recording method established did show the variability between the mastoid sinuses between individuals, but leaves room for future research. This project did not establish a consistent and useable measuring system for use in daily practice but did establish that there is high correlation between certain measurements and that if a better measuring tool is utilized, a more consistent and useable measuring system may be established to aid in making positive identification for human remains.

Comparative Radiology, Human Identification, Mastoid Sinuses

H82 The Petrous Portion of the Human Temporal Bone Revisited: A Bayesian Analysis of its Potential Value in the Identification of Human Skeletal Remains

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The goal of this presentation is to inform the attendee of the utility of the petrous portion of the temporal bone, as seen on axial head CT, in the identification of human remains, and will discuss the results within the framework of Bayesian theory in light of recent federal court requirements regarding forensic testimony.

This presentation will impact the forensic community and/or humanity presenting a novel means for identifying fragmentary human skeletal remains with a high degree of accuracy; presenting the results of this research within the framework of Bayesian theory as a means to satisfy the most recent federal requirement for the admissibility of forensic testimony.

Recent federal court decisions, most notably including the Daubert vs. Merrell-Dow ruling (1993) require more demonstrable levels of repeatability and more substantial statistical support for forensic scientific testimony including identifications. Currently, the content of forensic testimony must: (1) be testable by the scientific method, (2) have been peer reviewed, that is, published in a peer-reviewed journal, (3) be accompanied by explicit and demonstrable reliability and error rates, and (4) achieved general acceptance within the relevant scientific community. For this reason, research in forensic identification has undergone a transformation that has significantly influenced the development of recent novel identification methods. Considerable recent attention has been levied on the statistical basis for positive identifications made specifically by forensic anthropologists (Steadman et al. 2006). Traditional anthropological methods of identification have been short on the type of

information necessary to satisfy the Daubert requirements. However, some more recent anthropological methods have been designed with these federal admissibility requirements in mind (Christensen 2003).

Wiersema (2006) presented preliminary results of an evaluation of the potential of the morphology of the petrous portion of the human temporal bone as seen on axial CT scans of the head as a means to generate identifications of fragmentary human skeletal remains. The current poster presents the final results of that study and considers them within the context of Bayesian theory in light of the recent rulings regarding the admissibility of forensic testimony.

The data used in this research were collected from axial CT images of the cranium. Two sets of images were collected for each of the 115 individuals in the sample so that Euclidean distance comparisons could be made between images of the same individual and images from different individuals. Two-dimensional coordinate data were collected from 36 landmarks on each of the CT images and the distances between each of the coordinate points were calculated to generate the data used in the statistical analyses. The author pared down this set of measurements using two different models (referred to as the biological and PCFA models). The measurement sets of both models were then compared to one another using nearest neighbor analysis, to test their relative efficiency in matching replicate images to one another. The results of both models were highly accurate. Three incorrect nearest neighbor matches resulted from the biological model and 5 from the PCFA model. The errors appear to have been the result of variation in the axial plane between the first and second scans.

The results of the nearest neighbor comparisons were then considered within the context of Bayes' Theorem by calculating likelihood ratios and posterior probabilities. The likelihood ratios and posterior probabilities were very high for both models, indicating that: 1) there is significant individual variability in the measurements of the petrous portion used in this research, and 2) this variation represents a high level of potential accuracy in the application of this method in the identification of forensic remains. This poster will illustrate these results and compare them to the results of other identification methods including DNA.

Forensic Identification, Petrous Portion of the Temporal Bone, Axial Computed Tomography

H83 Mandibular Morphology as an Indicator of Human Subadult Age: Interlandmark and Geometric Morphometric Approaches

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The goal of this presentation is to outline how methods utilizing three-dimensional landmark coordinate data can be applied to problems in forensic anthropology. It will illustrate how these methods can be used to further knowledge about morphological differences in the subadult skeleton, with specific reference to age-related developmental remodeling of the mandible. This presentation will also show that in this specific analysis of data containing a strong allometric scaling signal, complex analytical techniques, compared to simple linear methods, do not necessarily confer a significant improvement in age prediction.

This presentation will impact the forensic community and/or humanity by providing data capable of predicting age using the subadult mandible with accuracy closely approaching that of standards based on the dentition. This technique has the potential to be a highly accurate means of age prediction in the subadult skeleton, which can be applied in situations where the mandible is fragmentary and/or the dentition is missing.

Age estimation from human skeletal remains is a well established practice in forensic anthropology and is one of the four key biological characteristics important in forensic identification. Age related changes have been documented for almost every part of the human skeleton, with the selection of an appropriate technique being inherently dependant upon skeletal preservation and the efficacy of the available standards. When developing or applying age estimation standards, due consideration must also be given to the effects of nutritional deficiencies or other environmental insults, and the degree of variability among individuals of a given age, both within and between populations¹.

Dental development and eruption is recognized as the set of developmental markers that appear to show the least variability against chronological age¹; these markers are thus widely used in forensic investigations involving both living and deceased individuals. Alternatively, there is an example in the literature of an attempt to determine whether infants (aged birth to 2 years) can be discriminated based on mandibular measurements². ANOVA statistics demonstrated that the best discrimination was obtained using ramus height, although no age prediction standards were formulated. However, this evidence does suggest that subadult mandibular morphology has a potential application in forensic age estimation, but four key issues require clarification: 1) determining the standard error of age estimation using the measurement of ramus height; 2) determining whether geometric morphometric methods provide more accurate age estimations; 3) determining whether age estimations are accurate beyond the first few years of life; 4) determining whether age estimation using mandibular morphology is sex and/or population specific.

The authors report here on new morphometric data designed to assess the potential of mandibular morphology as a developmental marker for estimating age at death in subadult human skeletal remains. A total of 79 subadult individuals (aged 1 to 17 years) were sourced from two documented skeletal collections (*The Hamann Todd Osteological Collection* and *The R.A. Dart Collection of Human Skeletons*). Sex and a statement of age are thus known for each individual. Thirty eight bilateral three-dimensional landmarks were designed and acquired using a Microscribe G2X portable digitizer. Linear regression was used to predict age using both the linear measurement of ramus height and the multivariate descriptors of mandible size and shape based on configurations of three dimensional landmarks. The accuracy of the different predictors was compared in the pooled sample and in subgroups by age (pre-pubertal individuals; ≤ 10 years and adolescents; > 10 years) and ethnicity. The best age predictor was then used to derive a simple linear regression model to predict age of subadults; the validity of the model was tested by cross-validation using a resampling procedure. Geometric morphometric analyses were performed using *morphologika*, *TPSSmall 1.20* and *NTSYS-pc 2.2f*; statistical analyses were performed using *SPSS 11.5* and *NTSYS-pc 2.2f*.

References:

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- 2 Norris SP. Mandibular ramus height as an indicator of human infant age. *J For Sci* 2002;47:8-11.

Age Estimation, Subadult, Mandible

H84 Assessment of Histomorphological Features of the Fourth Rib for Age Estimation in Koreans

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The goal of this study is to assess the histomorphological features, such as osteon population density, relative cortical area and average size of osteon and Haversian canal, of the fourth rib and ascertain the usefulness of histological age estimation method based upon Koreans.

This presentation will impact the forensic community and/or humanity by suggesting the possibility for histological age estimation method based upon Koreans. And this study is a first attempt for histological age estimation method using the fourth rib in Koreans, so it will be contribute to growth of concern for forensic anthropology of forensic sciences in different countries as well as Korea.

Many studies on histological age estimation methods have been made for different bones and populations. Through these reports, the authors have a query about histomorphological variations associated with age in the fourth rib and have need of histological age estimation method applicable to Koreans. The objective of this study is to assess the histomorphological features of the fourth rib and ascertain the usefulness of histological age estimation method based upon Koreans. In this study, 26 rib samples (13 males and 13 females) adjacent to the sternal ends (about 5 cm lateral to costochondral joint) of cadavers with known age and sex were used. The age range for the sample is 33 to 89 years with a mean and standard deviation of 65.0 and 16.5 years, respectively. Two thin sections (less than 100 μm thick) per individual were prepared for histological analysis by manual grinding method. Osteon population density was counted using an Olympus BX-51 light microscope with 20x objective and 10x oculars fitted with 10x10 eyepiece reticule (grid factor 0.25 mm^2), and relative cortical area and average size of osteon and Haversian canal were measured using image analysis solutions (Image-pro Plus 4.5.1, Media Cybernetics, Inc.). Statistical regression analysis was performed using age at death as dependent variable. In case of combined sexes, osteon population density showed positive correlation coefficient ($r=0.584$) and average osteon size showed negative correlation coefficient ($r=-0.778$), while relative cortical area and average Haversian canal size showed no correlations with age. For simple regression method, average osteon size was selected as independent variable and its R squared and standard error of estimation were 0.605 and 10.564, respectively. Meanwhile an analysis of covariance (ANCOVA) showed significant difference only in osteon population density between the sexes, so when the data for males and females were split for simple regression analysis, each of their R squared was increased from 0.341 in combined sexes to 0.649 in males and 0.378 in females. These results fall within the purview of preliminary study but show the possibility for histological age estimation method based upon Koreans.

This work was supported by the Korea Research Foundation Grant funded by the Korean Government (MOEHRD) (KRF-2006-331-E00011).

Age, Rib Histomorphometry, Koreans

H85 Age-Related Histomorphometric Changes in Fetal and Infant Long Bones

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After attending this presentation, attendees will gain an understanding of how histological changes in the long bones of fetuses and infants may be used to estimate age at death of fragmentary skeletal remains.

This presentation will impact the forensic community and/or humanity providing a preliminary investigation into the potential of utilizing histomorphometry in the estimation of age at death of fetal and infant remains. Microscopic methods may prove invaluable to the task of aging fragmentary remains that lack the characteristic features necessary for conventional methods.

The goal of this study is to investigate the age-related changes in histomorphometry among the femur, tibia, and humerus of fetal and infant skeletal remains. Histological studies have become increasingly important in distinguishing fragmentary human remains from non-human remains^{1,2}, as well as estimating age at death in forensic cases^{3,4}. However, little work has been done with subadult material due to its distinct growth patterns and unique microscopic composition.

This study will impact the forensic community and/or humanity by providing a preliminary investigation into the potential of utilizing histomorphometry in the estimation of age at death of fetal and infant remains. Microscopic methods may prove invaluable to the task of aging fragmentary remains that lack the characteristic features necessary for conventional methods.

With permission from the mothers, cadavers were donated to the anthropology department by the University of Tennessee Regional Medical Center. Only fetuses and infants of known gestational age and those lacking pathological conditions that affect skeletal maturation were deemed adequate for study. The sample consisted of fetuses and infants of ages varying from 20 weeks gestation to 12 postnatal months. The femur, tibia, and humerus were chosen for study because previous research has suggested that these elements show more characteristic age-related changes in the adult than other skeletal elements. Since fragments of long bone shafts are often comprised of areas other than the midshaft, the entire diaphysis was utilized for study. Nine thin sections were cut from each bone (three each from the proximal third, middle third, and distal third of the diaphysis) using a high-concentration Buehler Isomet 1000 diamond blade saw. All sections were analyzed with a Leica DMRX light microscope at 5x, 10x, and 20x power magnification. Histomorphometric analysis was conducted using a Dell Optiplex GX270 and Image-Pro Express software. Seven measurements were recorded for each thin section - diaphyseal diameter, medullary diameter, cortical thickness, cortical area, osteon population density, osteon cross-sectional area, and percent non-remodelled bone.

Previous research conducted on changes in urinary excretion of the N-terminal telopeptide of type I collagen suggests that the rate of bone turnover in neonates increases up to 37 weeks gestation, slows around the time of birth, and increases steadily thereafter⁵. These changes are closely associated with the pattern of growth of the neonate; therefore, researchers can expect histological changes to follow a similar pattern. Osteon population density and percent non-remodelled bone seem the more promising measurements in detecting age-related histomorphometric changes.

References:

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Subadult, Histomorphometry, Age Estimation

H86 Utilization of the Iscan Method on Multi-slice Computed Tomography Reconstructions for Assessment of Aging: A Preliminary Study

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The goal of this presentation is to assess the possibilities of aging on two (2D) and three dimensional (3D) multi-slice computed tomography reconstructions of the sternal end of the fourth rib using the Iscan method.

This presentation will impact the forensic community and/or humanity by providing an example of anthropological application of the computed multi-slice computed tomography in forensic sciences.

Goal: The goal of this presentation is to assess the possibilities of aging on two (2D) and three dimensional (3D) multi-slice computed tomography reconstructions of the sternal end of the fourth rib using the Iscan method.

This presentation will impact the forensic community and/or humanity by providing an example of anthropological application of the computed multi-slice computed tomography in forensic sciences.

Background: Multi-slice computed tomography (MSCT) is uncommonly used in forensic pathology and anthropology. MSCT allows two (2D) and three-dimensional (3D) reconstructions, which can be helpful for osteoscopic analyses and consequently for age estimation.

Purpose: To evaluate the possibilities of aging adults by examination of MSCT 3D reconstructions the sternal end of the right fourth rib with the Iscan method.

Technique: Thirty-nine sternal ends of the fourth right rib were taken during medicolegal autopsies and examined before cleaning with a sixteen-detector row MSCT (Sensation 16, Siemens). Two filters of reconstruction were used: one "hard" for bone examination and the other one "smooth" for soft tissues examinations. The thickness of reconstruction was 1 millimetre and the collimation 1 millimetre. Two (with the MPR mode (Multi Planar Reconstructions)) and three-dimensional post-processing (with the VRT mode (Volume Rendering Technique)) were made in all cases. MPR reconstructions were performed in two planes: one along the long axis of the sternal end of the rib and one along short axis.

Using the Iscan technique, the phase of each subject (and consequently the range of aging) was assessed by three different observers. One observer was an anthropology student and two were forensic pathologists with anthropological qualifications.

The ribs were carefully cleaned with alternate baths of hot water and flesh removal. After a spontaneous drying, the phase of the sternal end of each rib was assessed by the Iscan technique by the three different observers.

A first statistical analysis was performed to evaluate intra and inter-observers variabilities on MSCT reconstructions and on dry bones by calculating the coefficient Gamma and the Krippendorff's alpha reliability. A second statistical analysis was performed in order to compare estimations of phases performed on MSCT reconstructions and on dry bones by each observer (inter-method evaluation). Because of the little number of subjects studied, the statistical test used in this case was the Krippendorff's alpha reliability.

Results: The sample studied consisted of thirty-eight subject. Two ribs were excluded because of their partial destruction during their cleaning.

The intra-observer variabilities on dry bones were excellent with the coefficient of Gamma equal to 0.87 and confirmed by a value of the Krippendorff's alpha reliability equal to 0.79. The intra-observer variabilities on MSCT reconstructions were excellent with the coefficient of Gamma equal to 0.86 and confirmed by a value of the Krippendorff's alpha reliability equal to 0.79.

The inter-observers variabilities on dry bones were good with the coefficient of Gamma ranging from 0.73 to 0.91 and confirmed by a value of the Krippendorff's alpha reliability ranging from 0.68 to 0.83. The inter-observers variabilities on MSCT reconstructions were excellent with the coefficient of Gamma ranging from 0.82 to 0.88 and confirmed by a value of the Krippendorff's alpha reliability ranging from 0.78 to 0.86.

Concerning the inter-method evaluation for the first observer (student), the value of the Krippendorff's alpha reliability ranged from 0.55 to 0.71. The agreement between phase estimation for both methods was acceptable, even good.

For the second observer, the value of the Krippendorff's alpha reliability was equal to 0.69. Consequently the agreement between estimations of phases for both methods was significant.

For the third observer, the value of the Krippendorff's alpha reliability was equal to 0.71. Consequently the agreement between phase estimations of phases for both methods was significant.

Discussion: Concerning the inter-observers variabilities, results were better on MSCT reconstructions.

Concerning the intra-observer variabilities, results were equal for both methods.

The inter-method error varied according to the observer. Evaluations of phases for both methods were seldom made with a perfect concordance. Percentage of evaluation with a difference of one phase (more or less) varied from 64% to 81%, what is correct.

For phases 4 or more analysed on dry bones, observers had tendency to under estimate the phases on the MSCT reconstructions.

Some explanations about this were made:

- the thickness of the wall of the sternal end of the rib is sometimes difficult to be evaluated on MSCT reconstructions;
- porosity of the bone is not estimable on MSCT reconstructions;
- but analysis of fragile osteophytes on MSCT reconstructions is excellent.

Conclusion: Using MSCT reconstructions of the sternal end of the fourth rib in order to estimate the phase and therefore the age of a person using the Iscan method is possible and seems to be efficient.

This study is a preliminary study and analysis on a larger population is necessary to evaluate real possibilities of age estimation on MSCT images.

Rib, Computed Tomography, Age Assessment

H87 Estimating Time Since Death From Human Skeletal Remains by Radioisotope and Trace Element Analysis

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After attending this presentation, attendees will understand a potential new technique to estimate time since death.

This presentation will impact the forensic community and/or humanity by giving forensic anthropologists another way to estimate time since death. It will also encourage people from different countries to try this technique on human material from their own country.

One of the first concerns for forensic anthropologists in dealing with found skeletal remains in the Australian context is the determination of whether the remains are of anthropological, historical or archaeological interest. If fewer than 75 years have lapsed since death, remains are classified as anthropological and of forensic interest. Those from the historical (75-149 years dead) and archaeological (>150 years dead) periods are, if aboriginal subject to the Aboriginal and Torres Strait Islander Heritage Protection Act 1984. However, an accurate and reliable method for estimating time since death (TSD) from human skeletal remains has thus far eluded forensic anthropologists. This study investigates the application in an Australian context of a novel approach recently proposed to dating skeletal remains from levels of radioisotopes ^{210}Po , ^{238}U and ^{226}Ra and trace elements. Radionuclide activity concentrations were by determined alpha spectrometry and trace element concentrations by inductively coupled plasma mass spectrometry (ICP-MS).

Discriminant analysis of the combination of activity concentration values for ^{210}Po , ^{238}U and ^{226}Ra clearly separated bones derived from individuals who had died in the three eras of interest, as did the combinations of trace element concentrations. Bone radionuclide activity and calcium concentrations were all significantly higher in bones from the archaeological era than those from more recent eras, while trace lead concentrations from samples from the historical era were significantly higher than those from other eras. Barium, lanthanum, rubidium, strontium, cerium and neodymium concentrations were all significantly correlated with one another and with radionuclide activity concentrations. Significant differences were found between the patterns of radionuclide activity and trace element concentrations in different types of bone.

The results of this study lend support to suggestions that multivariate consideration of trace element concentrations and radionuclide activity levels can aid in the estimation of time since death from bony remains in Australia. This was a very small study, but its results clearly indicated the need to take into account variations arising from lifetime activities, diagenesis and bone type in applying the techniques to estimations of time since death. It highlights the great need for a large scale study which systematically examines these influences on the estimation of time since death in bone of known ages ranging from the very recent through to archaeological times.

Time Since Death, Radionuclides, Forensic Anthropology

H88 Even in Alaska! Missing Person or Cremains and How to Tell the Difference

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After attending this presentation, attendees will learn about a model that can be used when unidentified burned bone fragments are found and that will assist scientists of various disciplines to recognize human cremains.

This presentation will impact the forensic community and/or humanity by providing a model that can be utilized by investigators when confronted with unidentified burned osteological fragments and by demonstrating how microscopic analysis and the cooperation of various professionals can aid in the analysis of various specimens in order to identify missing individuals and/or cremains.

New trends in the funeral industry are posing a challenge for forensic scientists. There is an increased interest in customized and non-traditional services, as well as a growing number of people choosing cremations over burials as their preferred form of body disposition. Careful collection and scene documentation is crucial whenever unidentified remains are found. The initial step in these cases will always entail attempting to determine animal vs. human bone. When fragments are very small, this may not be possible. If the fragments are human or if there are obvious artifacts such as teeth or clothing associated with the remains, the accepted protocol is then to attempt to match the remains with missing persons last known to be in the vicinity. All evidence and remains found at the scene need to be collected for further analysis. In this case study, the presenters will document the steps used to analyze small bone fragments, present visual representations of burning patterns in bones, and help forensic scientists determine cases involving foul play by burning versus standard cremation practices. The presentation will also include visual representations of cremation artifacts and the procedures utilized in the funeral industry during the cremation process. It will demonstrate how common cremation artifacts can be misidentified to the untrained eye and will include the most common type of items found when an individual is cremated and then their ashes scattered.

Cremains, Physical Anthropology, Forensic Odontology

H89 Forensic Anthropology Investigation of Human Rights Violations in the Ixil and Ixcán areas of Guatemala

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After attending this presentation, attendees will learn about the results obtained by the Centre for Forensic Analysis and Applied Sciences (CAFCA) from their investigations during the last five years as well as patterns of human rights violations during the armed conflict in the two areas of Guatemala as it relates to perpetrator, sex, and age of victims, and types of perimortem trauma.

This presentation will impact the forensic community and/or humanity by demonstrating a first effort to organize and analyze the data that has been collected by one of the Guatemalan teams (CAFCA) and to give emphasis to the need for further studies as a means to understand the magnitude of the events that occurred as well as provide elements for comparative studies in other countries that face a similar context.

Guatemala lived through one of the most violent armed conflicts in Latin America (1960-1996). During the 1980s, the strategies created by the State were aimed to terrorize the civilian population. The result of these strategies was widely recorded by two historical investigation projects in 1998 and 1999. Both reports recorded a huge number of witness and survivor testimonies and documented the human rights violations with a historical and memory recovery perspective.

Between 1992 and 2005 four forensic anthropology teams carried out approximately 600 exhumations, recovering and analyzing an average of 4,000 skeletons.¹ The Guatemalan teams have provided a number of additional findings and have been able to document cases that were not reported to either of the investigation teams mentioned above.

The analyses of the data that have been collected through the years offers a tool for understanding the magnitude of the violent events that occurred in the country and facilitates classification of events for further research. It might also provide elements for comparative studies since other nations have experienced or are at the moment going through similar socio-political situations.

This presentation will show the results of the systematization and analysis of the data collected by one of the forensic anthropology teams, the Centre for Forensic Analysis and Applied Sciences (CAFCA). The focal areas of this research are the forensic investigations carried out in the Ixil (northwest highlands) and Ixcán (north lowlands) areas of Guatemala. Patterning in the human rights violations that occurred during the armed conflict are presented in terms of perpetrator, sex and age of victims, and types of perimortem traumata. This research is based both on eyewitness interviews and on the evidence that has been collected by CAFCA's team between the years 2000 and 2005.

Reference:

¹ Information from FAFG, CAFCA, ODHAG-EAF and Forensic Anthropology Team of the El Quiché Diocese.

Forensic Anthropology, Human Rights, Guatemala

H90 Most Common Variation and Dental Anomalies in Skeletons Analyzed in the Laboratory of the Guatemalan Forensic Anthropology Foundation

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After attending this presentation, attendees will be introduced to data obtained about morphology, variation, and dental anomalies of the skeletons analyzed in the FAFG that will demonstrate differences with other groups or populations.

This presentation will impact the forensic community and/or humanity by demonstrating the importance of odontology in forensic anthropology in Guatemala for identification of individuals.

In several cases, features were observed in the teeth that are not common to all dentition, or to all persons. Occasionally, these features were scored as anomalies until a review revealed that they were in fact morphological variation. Occasionally, these variations were a difference of major or minor grade that does not alter the form of the tooth but gives it a different appearance. Anomalies are simply a deviation of normality. These deviations can occur as a result of local conditions, as well as inheritance or, in some cases, systematic alteration.

Dental anomalies not only affect tooth form, size, layout, number or time of eruption, they are also modifications of histological structure. The different teeth vary in length, width, thickness, curve of the root, features of the crown, evolution of the marginal crest, form, and definition of the cusp.

One of the most common questions is: what are the morphological features of the inhabitants of Guatemala? However, performing an investigation of this type would involve a population too big, therefore this study will specifically report on variation and anomalies observed in the permanent dentition of the skeletons recovered in the regions most affected by the civil war in Guatemala, which were analyzed in the laboratory of the Guatemalan Forensic Anthropology Foundation (FAFG).

Due to shortage of studies about dental morphology in the Guatemalan population, other data (from other groups) were used, because there are not enough investigations performed that could clearly prove if the dental morphology of the Guatemalan is the same or different from what it is commonly described.

Dentition, Morphology, Anomaly

H91 Diverse Stature Estimation Formulae Applied to a Bosnian Population

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The goal of this presentation is to evaluate the application of three different stature estimation formulae to a Bosnian population. This research project tests the accuracy of Trotter (1970), Ross and Konigsberg (2002) and Sarajlic (2002) formulae for stature estimation as applied to a Bosnian population.

This presentation will impact the forensic community and/or humanity by demonstrating how correct stature calculation could be crucial to solve the problem of establishing positive identification in mass fatality situations involving related individuals.

In cases where a deoxyribonucleic acid (DNA) report is generated on two, three or even four brothers that did not have children and cases with mixed remains from mass graves, especially secondary mass graves, accurate biological profiles, including stature estimation are critical to sorting the remains. Establishing which brother the remains represent, or (in mass graves) to find that part of the body that does not belong to the individual, or that only the bone from which the sample was taken belongs to the individual while other bones to somebody else can be assisted by correct stature estimations.

There are still more than 14,000 missing persons in Bosnia and Herzegovina from the recent war who are believed to be dead. The process of recovery and identification of the deceased will inevitably take the next several years. Besides the estimation of sex and age, stature estimation is the next most important factor contributing to the individuation of unidentified persons.

Since 1996, the Trotter (1970) formulae, developed on American Whites, have been used almost without exception to determine the stature of the population in Bosnia and Herzegovina. Experience in the recovery, anthropological examination and identification processes showed that those formulae have not always produced adequate results. In 2002, Ross and Konigsberg presented new formulae for stature estimation for Balkans, using bones from unidentified Bosnian and Croatian males who were victims of the recent war. Because the actual statures of those persons were not known, the authors used the mean and standard deviation of stature for 19-year-old males from the literature. The same year, 2002, in his master thesis, Sarajlic also presented formulae for stature estimation of Bosnian population. The research was undertaken on male cadavers. The cadaver length was measured directly and the length of the long bones was obtained from radiographs.

An additional problem in Bosnia and Herzegovina is lack of records for either measured or reported height of the missing. The majority of military records containing such data were destroyed during the war. Therefore, in more than 95% of cases data about height of missing persons were obtained from family members. Since there are still many missing

persons in Bosnia and Herzegovina the identification of exhumed skeletal remains could benefit from using accurate formulae for stature estimation. Given the absence of antemortem data for height of the missing, estimated forensic stature (by close relatives) has to be considered as equivalent to biological stature in this situation.

The sample for this research consists of long bones (humerus, femur, tibia and fibula) and was obtained from 400 males exhumed in Bosnia and Herzegovina. The maximum length of the long bones was measured. In each case, the identity of deceased persons was provided by DNA and confirmed by the comparison of antemortem with postmortem data. All individuals in the study were aged from 19 to 58 years. In only 4% of the cases there were either military or medical records for stature of those persons. In 2% of the cases family members reported exact stature of the missing person. In all other cases, data about height was recollected by family members. In each such case measurements of a surviving male cousin, who were mature before the war, were taken and the height of the missing person was estimated according to their height.

Ross and Konigsberg showed in their research that formulae based on Trotter (1970) systematically underestimate stature in the Balkans. Sarajlic stated that the Trotter formulae underestimate the stature of tall people in Bosnia. In his study, the comparison with Trotter's method was made with the same sample from which the new formulae were derived. However, none of these formulae were tested on the bones from exhumed persons. This study compares all three methods on a large independent sample in order to determine which formulae provide the most accurate stature estimation for the male population in Bosnia and Herzegovina.

This research conducted on Bosnian remains from the recent war (1992-1995) might be helpful not only in the identification of the missing from the war, but for new forensic cases in Bosnia and Herzegovina as well.

Forensic Anthropology, Human Identification, Stature Estimation

H92 A Simple Technique for Imaging the Human Skeleton: An Application Using the Auricular Surface for Aging

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After attending this presentation, attendees will learn a simple technique using a photographic scanner to record images of the human skeleton without the distortion that can arise from using film and digital cameras. An example is provided using the auricular surface of the ilium from a collection of known ages at death for better aging purposes.

This presentation will impact the forensic community and/or humanity by demonstrating The impact of this presentation on the forensic community is that there are numerous applications.

A simple imaging technique utilizing a flatbed scanner is employed for the purpose of recording human skeletal remains without the distortion that can arise from using film or digital cameras. An application using this technique is provided in which images of the auricular surfaces of the pelvic ilium bones are presented in an effort to facilitate aging of the skeleton. The auricular surface of the ilium is a three-dimensional area that can be difficult to record photographically. Furthermore, some finer features such as granulations can be lost using film or digital cameras for imaging this and other skeletal structures.

Black-and-white photographic images of the auricular surfaces of ilia, traditionally shown along with descriptions of different ages at death, demonstrate photographic contrast that can make aging difficult. Several factors may contribute to photographic distortion, including such variables as the type of lighting, the angle of the lighting source, the camera type, and the image resolution, but a flatbed scanner with sufficient resolution

capabilities can provide digital images with clarity that can be readily shared by researchers. Additionally, image databases can be created with this technique.

For the purpose of this study the following methodology is espoused utilizing a relatively new collection of modern human skeletal remains of known individuals from Europe. Fifty auricular surfaces with known age-at-death were scanned with a flatbed scanner possessing sufficient resolution capabilities. The ilia used in this study are from the Modern Human Skeletal Reference Collection of the University of Athens, Greece. The University of Athens' Collection is comprised of approximately 200 known individuals from around Greece with pertinent associated data, including individual sex, age-at-death, cause of death, and occasionally specific antemortem medical information. Three different observers used the scanned images to estimate ages at death using a well-known auricular surface aging method. The results were then compared to those from observations of ages at death made both on photographic images of this subsample as well as observations of these subsamples by direct examination of the dry bone. The data were then statistically compared using an analysis of variance test with the SPSS statistical package with results indicating the utility of this technique. It is suggested that ages at death from scanned images are similar to those from observations made on dry bone.

In conclusion, this is a simple technique utilizing a flatbed scanner with sufficient resolution capabilities that allows for imaging skeletal features without the distortion that can present itself with digital or film cameras. Furthermore, this technique allows for readily sharing images and it can be used for the creation of digital databases as well. Discussion ensues regarding possible additional applications using this technique, such as the recording of pathological lesions or pubic symphyses of the pubic bones of the os coxae, again for aging purposes.

Imaging Technique, Human Skeleton, Aging

H93 Analysis of Commingled Remains Using Archaeology, Anthropology, and DNA: A Case Study from North Korea

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After attending this presentation attendees will learn how archaeological context, forensic anthropological analysis, and mtDNA analysis can be combined to understand the nature of a commingled skeletal assemblage and identify the individuals represented.

This presentation will impact the forensic community and/or humanity by demonstrating how commingled skeletal assemblages can be very difficult to interpret. Using multiple lines of evidence helps forensic anthropologists to understand assemblage formation processes, segregate the remains of different individuals, and identify the individuals present. This presentation will provide an example of how to understand a complex, commingled assemblage such as may result from a mass fatality event.

Teams from the Joint POW/MIA Accounting Command (JPAC) and its predecessor organization, the U.S. Army Central Identification Laboratory, Hawaii (CILHI) have excavated numerous archaeological sites in the Democratic People's Republic of Korea (D.P.R.K.) in search of the remains of U.S. servicemen who died during the Korean War (1950-1953). Remains recovered by these teams are analyzed at JPAC, and osseous and dental samples are sent to the Armed Forces DNA Identification Laboratory (AFDIL) for mitochondrial DNA (mtDNA) sequence extraction and analysis. Remains have been encountered in many different depositional circumstances. Some are clearly primary,

intact burials, whether of a single individual in a foxhole or eleven individuals in a mass grave. Others are secondary, with the bones of one or more individuals found out of anatomical position. Some of these secondary burials appear to be the result of recent activities by the Korean People's Army (K.P.A.), with whom JPAC teams collaborate. Others appear to be the result of battlefield clean-up activities in the 1950s, or reburial of remains disturbed by farmers at some point in the intervening decades. The authors report on an unusual secondary burial excavated by the CILHI in 2002. This recovery scene does not constitute a mass burial in the strictest sense of the term. None of the remains are articulated and there is a conspicuous absence of vertebrae, ribs, and hand and foot bones. The recovery scene is on a break in slope below a slight draw. Although the assemblage of bones appears similar to those found in obviously staged burials—primarily long bones, from at least nine individuals, with no apparent anatomical ordering—the archaeological context indicates that it is unlikely that the remains had been disturbed in the recent past. The eroded condition of the remains and the absence of smaller items suggest that these materials may have been deposited by flowing water. The apparent random orientation of the long bones suggests that the fluvial process was not linear. This pattern is consistent with the location of these remains in a supposed “eddy” against a bedrock depression. The angular sediment could be responsible for the extreme abrasion and lack of long bone epiphyses, especially in a fluvial environment. Although the remains appeared poorly preserved at a macroscopic level, mtDNA was comparatively well preserved, with sequence data obtained from all twenty samples initially submitted. This sequence data allows the calculation of the minimum number of individuals present (nine). Data has also been compared with that provided by family references for casualties known to have been lost in the vicinity of the recovery scene, indicating that the individuals represented are indeed American soldiers who died nearby in the fall of 1950.

Commingling, Archaeology, mtDNA

H94 Investigating the Spanish Civil War: Forensic Anthropological Investigations in Santaella

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After attending this presentation, attendees will learn about the current internationally collaborative forensic efforts in Spain by highlighting the results of one of the first systematic excavations and identifications of a Spanish Civil War mass grave. The paper discusses some of the unique problems of working in Spain, including current political obstruction of investigations and the nature of antemortem information.

This presentation will impact the forensic community and/or humanity by demonstrating The forensic community must continue to contribute to the training of international colleagues and help apply political pressure to promote scientific human rights investigations.

The Spanish Civil War officially began in July, 1936, as the military and right-wing fascists challenged the democratically elected Republican government. As part of a systematic strategy of terror in southern Spain, fascists supported local uprisings and the killing of Republicans and leftists. The relative peace the small village of Santaella had enjoyed that tumultuous summer was shattered on September 11 of that year. A group of fascist soldiers and civilians belonging to the Spanish Falange interrupted a village-wide celebration and kidnapped 18 men. The men were loaded onto a truck and taken to a neighboring village. One man

jumped from the moving truck and escaped but the others were transported to a cemetery and forced to dig a trench for their own mass grave. There they were executed. A few months later several more men disappeared from Santaella and were suspected to be buried in the Santaella cemetery. All of the victims were civilians. One was a shoemaker, another a municipal employee and the rest were farmers. For the next 68 years the families were denied access to their missing and were purposefully intimidated by those loyal to President Francos' authoritarian regime. The social climate of national amnesia related to Fascist atrocities continued even after Franco's death in 1975. In 2004 the families of the victims were finally given some hope of finding their loved ones.

A regional social organization, Foro por la Memoria, enlisted the assistance of Spanish archaeologists and an American forensic anthropologist to locate the mass grave(s), recover the remains, and identify the victims. In June of 2004 a hand dug trench was found inside the LaGuijarrosa cemetery. Seventeen skeletons were tightly packed together, side by side, with alternating head direction. Artifacts recovered included a variety of bullets, some metal personal effects, and leather clothing remnants, such as sombreros and boot soles. Simultaneously, another team of archaeologists searched for the other missing men in the Santaella cemetery. Five skeletons were exhumed from three graves at this site.

In August 2005, forensic anthropologists from Binghamton University joined two physical anthropologists from the Universitat Autònoma de Barcelona (UAB) to conduct a complete analysis of the 22 skeletons recovered from the La Guijarrosa and Santaella cemeteries. Standard methods of age, sex, and stature estimation were employed and pathological conditions were recorded. Perimortem and postmortem trauma were also described and diagrammed.

All of the recovered skeletons were male and most were young. Skeletal estimates of age indicate seven men were between 18 and 30 years, 14 between 30 and 50 years, and one was estimated to be over 50 years. Sixteen of the 22 individuals (72.7%) displayed clear evidence of perimortem trauma, 14 from LaGuijarrosa and two from Santaella. All of these individuals exhibited perimortem gunshot trauma and one also suffered blunt trauma to the face and head. The majority of the gunshot wounds are observed in the torso and limbs with only three men suffering one or more gunshot wounds of the head. This patterning of gunshot wounds supports a purportedly common scenario during the war in which the victims stood against the cemetery wall and the assassins fired from the hip.

Due to the lengthy postmortem period, antemortem information is derived from photographs and the recollection of family members concerning dental, physical and health characteristics rather than formal dental and medical records. Stature was not helpful for identifications because none of the individuals were particularly short or tall. Only one individual exhibited any dental treatment and was tentatively identified. Other presumptive identifications can be made based on antemortem fractures and the estimated age of the most elderly male but confirmation must await DNA testing.

Forensic Anthropology, Human Rights Investigations, Trauma

H95 Sifting Through the “Ashes”: Age and Sex Estimation Based on Cremains Weight

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The goal of this presentation is to: 1) to examine the relationship of cremains weight and age and sex; and 2) to address the discrepancy in average weights found in previous studies in comparison to a large sample from northern California.

This presentation will impact the forensic community and/or humanity by demonstrating the potential use of cremains weight in the estimation of age and sex from cremated human remains.

Cremated human remains have been the focus of numerous studies in recent years. This research has focused primarily on the use of coloration, shrinkage and fracture patterns to deduce the duration of heat exposure, as well as the condition and placement of the remains before contact with fire. Little research has been conducted into final cremains weight and the information which may be gleaned from it. Due to the practice of pulverization of fragments in modern cremations, traditional methods of sexing and age estimation are lost. Three studies have addressed this issue using cremains weight, with varying results. Sonek (1992) presented his findings at the 44th AAFS Annual Meeting, and reported a mean weight of 2380g for the group and 2824g and 1922g for males and females respectively. Warren and Maples (1997) showed similar results in their study of 100 individuals, with a mean weight of 2430g for the group, 2893g for males and 1840g for females. Interestingly, Bass and Jantz (2004) found that remains from a commercial crematory in Tennessee weighed approximately 500g more for both males (3379g) and females (2350g) than the Sonek (1992) and the Warren and Maples (1997) studies. Bass and Jantz (2004) suggest that these higher weights are due to regional differences in populations, with people having higher bone density in Tennessee due to higher obesity rates in comparison with Florida and California. With so few studies addressing this issue, the examination of another comparative sample can address discrepancies between previous studies, in particular whether regional distinctions in populations are the underlying cause of the difference.

The sample used in this study comes from the Newton-Bracewell crematory, located in Chico, California. Beginning in December 2003, crematory staff began weighing the cremains prior to release to the next of kin in order to combat potential litigation. With an average of twenty cremations monthly, each cremation was weighed on a postal scale and measured in pounds. The weight in pounds was converted to grams using the equation: Lbs x 453.6 = Grams. The cremains were weighed after placement into an urn, with the weight of the urn previously recorded and subtracted from the total. The sex, date of birth and death, cremation date and operator of the cremation were compiled using the operator's log, along with the permit for disposition of the body. The decedent's age was calculated from the birth and death dates. Unfortunately, the actual body weight at death was not obtained but the approximate body weight was noted for each individual by the funeral home staff. Individuals with a body weight at death higher than 300 lbs for males and 200 lbs for females are examined in this study to determine if higher body weight results in higher cremains weight.

Preliminary analysis of a subset (n=272) of the larger Chico sample produced the following results. The average weight for the group ($X=2683g$), males ($X=3177g$) and females ($X=2218g$) are similar to the mean weights reported by Bass and Jantz (2004). The difference between males and females is significant ($t=11.45$, $df=258$, $p=.001$), confirming the results found in all previous studies (Bass and Jantz 2004, Sonek 1992, Warren and Maples 1997). The correlation between cremains weight and age also confirmed previous findings. Cremains weight was found to decrease as age increases, with females ($r^2=.294$, $p=.001$) decreasing more rapidly than males ($r^2=.178$, $p=.001$). The preliminary sample did not yield a sufficient subset of males over 300lbs and females over 200lbs for analysis. Further research is needed to confirm these results for the larger Chico sample, as well as address the relationship between body weight and cremains weight. These results are expected to play an important role in future civil and/or criminal litigation concerning cremated remains, in both a forensic capacity and for the funeral industry.

References:

¹ Bass, William and Richard Jantz, Cremation Weights in East Tennessee. *Journal of Forensic Science*. 49(5):901-904

² Sonek, Alexander, 1992, The Weight(s) of Cremains. *Proceedings of the 44th Annual Meeting of the American Academy of Forensic Science*. New Orleans, LA. Feb. 17-22. P169-170

³ Warren, Michael and William Maples, The Anthropometry of Contemporary Commercial Cremation. *Journal of Forensic Science*. 42:417-423.

Cremains Weight, Age, Sex

* Presenting Author

H96 Burned Human Remains: Myths in Forensic Science

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After attending this presentation, attendees will understand how observation-based experimental research improves answers to old questions or problems in the field.

This presentation will impact the forensic community and/or humanity by re-examining old problems with current techniques and technologies.

Current developments in forensic anthropology have taken the field in a new direction by embracing methodologies, technologies, or techniques from other subdisciplines such as biology, chemistry, engineering, pathology, and fire investigation, just to name a few. Integrating these approaches allow the authors to reexamine old problems through new lenses. Experimental research allows for repeatable observation-based testing that either supports or provides alternative explanations to existing phenomenon encountered in forensic casework. This paper draws from observations of 12 human cadavers and 15 individual limbs utilized in previous burn experiments. The results presented are responses to current misconceptions that directly influence recovery and analysis of burned human remains. One goal is to first improve the ability of scientists to look closer and with fresh eyes at the evidence. Then it becomes the responsibility to teach each other and other professionals working within the medicolegal system. In some cases, an alternative explanation for long-held traditions opens the door to change and improvement. This paper attempts to provide new ways of looking at old problems by responding to the comment, "**I was taught that...**"

"...Blisters indicate the victim was alive or the presence of accelerants." Blister production is not necessarily evidence of antemortem vital reaction, but instead occurs from the effects of heat to skin moisture in both ante- and postmortem exposure to fire. Blisters result from fluid (water, blood, lipids) collection at the dermal-epidermal junction upon initial heat exposure to skin and may precede or accompany early color changes in the postmortem state and in the absence of accelerants.

"...Arms and legs burn away." Contrary to popular belief, smaller distal bones do not burn away but simply fall below the mass of charred human remains as supporting soft tissues burn away from fingers, wrists, toes, and ankles. In most cases these are present and discoverable with observant excavation and recovery. Bones of extremities do not burn away but instead may appear absent from extreme fragmentation of weak from strong bone or lack of recovery. Often the charred bulky torso is assumed to be all that remains of a burn victim and may be prematurely removed. Incomplete recovery leaves body parts at the scene and disregards potential skeletal evidence of defensive cut marks of the hands, callouses of healed fractures, or any congenital deformations that would aid personal identification.

"...Broken bone prevents pugilistic posture." Several traumatized limbs with known sites of completely fractured bone did not prevent adjoining distal joints of wrists, fingers, ankles, and toes from flexing. Also, amputated limbs completely transected at the humeral or femoral midshafts did not affect flexion of distal joints as movement of these was influenced by localized tissue contraction. The pugilistic posture is more the result of contraction of tissues immediately adjacent to the joint and does not depend upon a 'fulcrum effect' involving either an intact or complete musculoskeletal system intended to move the joint in life. The fractured sites of long bones were under direct influence of contracting muscle, causing bone fragments to either slide over one another or split apart depending on thickness of the surrounding tissues.

"...Bone color indicates temperature of the fire." Color simply indicates the stages of pyrolysis of organic bone materials. Color directly correlates with the progression of soft tissue reduction and organic pyrolysis of bone rather than as an indicator of temperature levels.

Identical features of charring and calcination can occur in a body burned at extremely high temperatures for a short time period or one burned at lower temperatures for a longer duration. Time and temperature are independent variables that can produce similar heat effects in burned human remains. Color can be superficial with an external calcined appearance, but still retain charring within deeper layers of bone.

“...Bone shatters from heat.” The exterior cortical surfaces of bone are exposed to heat the earliest and longest compared to deeper layers insulated within soft tissues (tubular bone or cranial bone). Visible changes of color and heat-fractures commence externally and progress inward. Heat causes cortical bone to shrink and split into superficial heat fractures as it loses its organic constituents. Heat fractures likewise will shrink and split first at the external cortical surface and can travel through the bone as a full-thickness fracture. Fractures allow heat to reach lipid rich tissues of marrow and brain, causing them to leach and burn out, but not shatter bone.

“...The skull explodes if there’s no injury.” In a fire, cranial bone experiences color changes and heat-fractures; often as delamination, crazing, or full-thickness fractures. Also external taphonomic factors typically present at fire scenes contribute to the ‘exploded’ appearance. Fragile burned cranial bone also fractures during burning from environmental disintegration, impacting debris of collapsing walls, ceiling, floor, and furniture, and from extinguishment methods. If one accepts the fragmented or ‘exploded-looking’ skull as proof for the absence of preexisting trauma, it discourages further investigation of evidence for possible homicides. Additional fragmentation of fragile burned cranial bone can result from recovery and transport from the fire scene.

“...All bodies burn the same.” Trying to predict what a body will look like during search and recovery after an extensive fire requires basic knowledge of anatomy and osteology. The body is a fuel source and contributes to the burning process. There are obvious differences among individuals such as their weight, age, and sex that relate to differential amounts of soft tissues and body-fat ratios. Likewise, bone density and mineralization differs among babies, children, adolescents, adults, and the elderly. Denser mature bone survives heat better than osteoporotic bone of the elderly and immature bone of epiphyses and diaphyses of subadults. Prior knowledge of the victim’s information will help anticipate the final condition of remains during the search process.

Exemplars from observation-based research on burned human will be presented to illustrate the alternative mechanisms and processes responsible for creating each problem discussed.

Burned Bone, Fire Death Investigation, Myths

H97 Establishing the Perimortem Interval: Correlation Between Bone Moisture Content and Blunt Force Trauma Characters

Danielle A. Miller Wieberg, MA, 4107 Meredith Road, Knoxville, TN 37921*

After attending this presentation, attendees will understand some of the details of skeletal fracture morphology, how it varies throughout the postmortem interval and how bone moisture content affects that morphology.

This presentation will impact the forensic community and/or humanity by exploring the uncertainty in determining the timing (relative to death) of skeletal fractures and the results will impact the way fracture timing analyses are conducted and reported.

When determining the time of occurrence of skeletal injuries forensic anthropologists know that antemortem (before death) skeletal injuries are recognized by evidence of healing. Perimortem (at or near the time of death) and postmortem (after death) skeletal injuries are more difficult to distinguish between because neither show evidence of healing. Furthermore, bone does not immediately react in a postmortem manner as soon as an organism dies because it retains the moisture and collagen that gives bone its flexible nature. The perimortem interval is the period during the postmortem interval when a bone will react to injury in a typical perimortem manner rather than having the appearance of a postmortem modification.

Using 60 porcine long bones, the differences between macroscopic and microscopic blunt force trauma fracture characteristics were documented as they varied when created every 28 days throughout a 141 day period. It was also determined how those changes correlate with bone moisture content. The hypotheses tested were (1) there is no difference between fracture characteristics created during the period immediately after death (within 24 hours) and characteristics created five months (141 days) after death, and (2) there is no correlation between the moisture content of the bone and blunt force trauma characteristics.

An initial sample of ten bones was fractured to represent perimortem injury. The remaining fifty bones were placed in an enclosure to decompose and every 28 days another sample of ten bones was fractured. Once each set of ten specimens was fractured, they were photographed extensively before and after cleaning them in a mild detergent solution. The fractured bones were examined and the fracture surface appearance, fracture angle type, fracture outline type, and color differences were documented. Other observations that were recorded include: fragment mass, completeness of fractures, degree of bone weathering, and microscopic features of the fracture planes. Additionally, a small portion of each specimen was ashed in a muffle furnace to determine the moisture content of the bone at the time of fracture. Bones were assessed as having perimortem, intermediate or postmortem fracture morphology using all of the aforementioned observations.

Statistical results indicated that there was a significant relationship (1) between postmortem interval and ash percentage, fracture surface, and fracture angle; (2) between overall assessment and postmortem interval, ash weight, fracture surface, and fracture angle; and (3) between ash weight and fracture surface and fracture angle. Results showed that bone moisture content influences fracture morphology significantly.

Additionally, ten specimens were selected that represented all six postmortem intervals (0, 28, 57, 85, 113, and 141 days). These specimens were used in an interobserver study (IRB project #1054957) at the 2006 American Academy of Forensic Sciences Annual Meeting in Seattle, WA. Participants were asked to rate the fractures of each specimen as either perimortem or postmortem and list their determining criteria. The average score for the study was 6.82 and three of the 22 participants correctly identified the fracture timing of all ten specimens. Compilation of participants’ answers provided a list of six characteristics used by the participants: color differences between fracture surface and cortical surface, completeness of the fracture, presence or absence of plastic deformation, appearance of fracture margins, shape of the fracture outline, and fracture surface appearance.

Blunt Force Trauma, Perimortem, Fracture Morphology

H98 Bone-Breaking Rules: A Report of Six Fracture Mechanism-of-Injury Axioms Developed From Experimental Impact Testing

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After attending this presentation, attendees will learn about six widely applicable bone fracture axioms, useful in a forensic setting investigation and reconstruction.

This presentation will impact the forensic community and/or humanity by helping to further the understanding of bone fracture patterns and mechanisms of injury.

Understanding relationships among engineering inputs (i.e. loading characteristics) as they relate to anatomical outputs (i.e. fracture) of human long bones and the human head is very important for biomedical engineers, physical anthropologists, pathologists, and other forensic professionals. Developing widely-applicable bone fracture axioms is useful for forensic analyses. Therefore, a characterization of injury mechanisms of certain bones (i.e., in the extremities and the skull) in response to impact loading are delineated in the form of succinctly stated rules.

Real-life pedestrian, motor vehicle collision, and violent impact trauma scenarios were modeled by dynamically loading 583 human cadaver specimens, including intact extremities, heads, and bare long bones (numerous porcine bones were also used). A cart/guide-rail impacting system and a drop tower apparatus were used for most of the tests (the ballistic tests were done with a real handgun and a real rifle in bench rest position). Parametric work was conducted that varied numerous test variables such as loading direction, impact velocity, and impactor geometry.

The data support findings that may be reported in the form of succinct *Bone-breaking Rules*. *Rules 1, 2, 3, and 5* are based on 558 bone fracture tests using intact legs and bare long bones; *Rule 4* is based on 25 human head impact tests; *Rule 6* is based on numerous porcine tests.

1) *The point of a wedge is opposite of the point of impact.* The wedge fracture pattern can definitively be used as an indicator of the direction of impact. A common fracture pattern for long bones is the wedge fracture (also referred to as butterfly or delta fracture). Wedge fractures of long bones clearly originate at a location directly opposite of the point of impact and the wedge segment radiates back through the bone. Long bones fail in tension when they are loaded in a transverse fashion and a resultant wedge will “point” in the direction of the movement of the impactor.

2) *Comminution does not necessarily mean “high speed” and/or crushing.* This is somewhat of a unique observation because it has been commonly reported that butterfly wedges result only from high-speed impacts. Also, comminuted fractures often occur without entrapment (crushing injury). At approximately 7 m/s the inertial restraint of the tibia from just the mass of the thigh and foot is sufficient to result in comminuted fractures.

3) *Spiral fractures only appear when bones are subjected to torsional loads.* The spiral fracture is commonly mistaken for an oblique fracture and often the terms are used interchangeably or combined. The literature is replete with phrases such as “spiral oblique fracture”. There is clearly a difference between the spiral and oblique fracture patterns. The definitive feature for distinguishing a spiral fracture is the vertical fracture that connects the proximal and distal portions of the helical aspect. To interpret which direction the bone was twisted, an examiner can note which direction the spiral runs around the bone; that direction is the same direction the torque was applied to that end of the bone.

4) *Fractures of the skull radiate directly from the point of impact.*

In fracture pattern interpretations, some researchers have suggested that the point of impact is at a location other than the interface between the impacting object and the skull. This is not correct, i.e. the fracture epicenter is at the location of contact by the impacting object. Bone is brittle and the only exception noted with respect to fracture initiation being somewhere other than the interface of the bone and the impacting object is that of long bones when tension failure occurs.

5) *Impacted fractures indicate relatively pure axial loading.* However, an axial load can also give rise to bending fractures. If a fracture of a long bone is labeled as an impacted fracture, then the diaphysis of the bone experienced relatively pure longitudinal compression. If the compression (or axial load) gets “off-center”, the resulting failure mechanism can be bending.

6) *The degree of plastic deformation relates to the speed of impact.* This is almost a restatement of viscoelasticity. This rule involves a comparison of ballistic speed versus other speeds (such as pedestrian/vehicle collisions). What is particularly important about this rule is that it is not just applicable to mechanical properties of bone but it is also applicable to fracture behavior. This is easily illustrated through forensic reconstruction of ballistically-damaged bones (which express minimal plastic deformation) in comparison to lower-speed blunt trauma impacts which demonstrate a higher degree of warping and plastic deformation. Note, too, that bones are not damaged from soft tissue pressure waves from typical small arms, and that bones will exhibit a temporary cavity when actually struck by a projectile.

Bone Trauma, Mechanisms of Injury, Impact Biomechanics

H99 Trace Element Analysis of Human Bone Using Portable XRF

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The goal of this study was to investigate the utility of portable X-Ray Fluorescence (XRF) in the determination of trace element concentrations in human bone. The advent of portable analytical tools for field use presents new applications for the forensic scientist. However, with the new tools comes the challenge of sampling and data interpretation. Potential sources of error in interpretation of analytical results are discussed.

This presentation will impact the forensic community and/or humanity by providing practical insight into the application of portable XRF in analysis of human bone.

Portable XRF technology is a relatively recent introduction to the fields of art conservation, soil science, archaeology, border security and forensic science. XRF analysis gives a rapid reading of the elemental composition of any inorganic material with good sensitivity for elements above phosphorus in the periodic table. The Alpha series XRF from Innov-X (Woburn, MA) was used in this study. This unit utilizes a miniaturized X-ray source for excitation instead of a radioactive isotope, thereby eliminating the need for special permits for transportation and reducing the potential occupational exposure hazard of operators.

A pilot study of 8 cremated individuals was conducted to test the applicability of XRF in trace element analysis of human osseous material. The bone analysis using XRF focused on the trace elements lead (Pb), zinc (Zn), iron (Fe), and strontium (Sr), and concentrations were reported in parts per million (ppm). The pilot study revealed differences in elemental concentration between individuals as well as differences between skeletal elements analyzed (cranial vault, clavicle, humerus, vertebral body, femur, and tibia). These anatomical sites were selected because of differences in bone density. Two physical states of cremated bone were assessed; large

fragments as retrieved from the cremation retort and the processed, powdered cremains as prepared for inurnment.

The data show that there is variation in Pb between individuals and between bones. The range amongst all individuals for bone fragments was 0-203 ppm and 0-53 ppm for processed powdered bone. The high Pb level of 203 ppm was in a parietal bone of one individual whose other bones ranged between 0-61 ppm. This high reading was concluded to be surface segregation or contamination because after powdering this parietal bone gave a reading of 46 ppm. Powdering in this case had a homogenizing effect. Of note, the combined powder (all powdered bone together from each person) amongst all individuals ranged from 0-39 ppm. Similar but larger effects were noted for the element zinc (range of 0-1177 ppm in bone pieces and 0-329 ppm in powdered bone; combined powder 0-259 ppm). However, zinc is volatile at the temperatures experienced during cremation, so the resulting sublimation and evaporation effects may be expected to result in variations in surface concentrations. The most consistent data were recorded for the elements of Fe and Sr amongst all bones of all individuals. Only 1 of the 8 individuals had no reading for Fe or Sr in both the clavicle and vertebra. Excluding the zero values, Fe ranged from 199-2286 ppm in bone and 183-866 ppm in powdered bone amongst all individuals, with the combined powder range between 213-355 ppm. Graphically, the Fe concentration in the powdered skeletal elements adhered to a similar pattern for all individuals. There was a distinct peak for Fe (386-866 ppm) in the vertebral body powder for all 7 individuals, whereas the other powdered skeletal elements did not exceed 471 ppm for any individual or any bone. This finding suggests higher Fe concentrations in the cancellous bone of vertebral bodies. Sr concentrations, again excluding the zero values, ranged between 54-155 ppm in bone, 50-128 ppm in powdered bone, and 58-130 ppm in all combined elements amongst all individuals.

A possible source of error in determination of trace element levels is preferential surface deposition or segregation. If after homogenization, the element concentration appears to drop, then surface effects should be suspected. In addition, if bone of low density is presented to the analyzer, then the values for trace element concentration would be expected to be lower than higher density bone, assuming that the element concentration is the same. This is simply because less material is present in the analysis volume. Powdering in this case can reduce any effect associated with differences in bone density, assuming that the particle size in the powder is relatively homogenous. Furthermore, the hydration state of bone should be considered. In fresh bone the presence of water will absorb the characteristic emitted x-rays, thus giving a low concentration as compared to dry bone. This effect was demonstrated in this study by analyzing a piece of fresh parietal bone that was subsequently dried at 1000C for 30 minutes, and then re-analyzed.

XRF is a new technology available to the forensic community, not limited to anthropology, but with widespread uses in the crime scene laboratory in the enforcement of justice in drug trafficking, or for exposing the manufacture and disbursement of drugs and potential counterfeit materials. Also, within the field of anthropology and archaeology, handheld portable XRF promises to be another tool in the chemical and physical analysis of human remains, both biological and cultural. As with any other analytical technique, care must be exercised in sampling strategy, preparation of samples and data interpretation. The ease of use, rapidity of analysis and user-friendly interface of portable XRF units are beguiling. However, it is still a technique that demands knowledge of the analyst just as would a fully configured laboratory-based system.

X-Ray Florescence (XRF), Trace Elements, Bone

H100 Physical Matches of Bone, Tooth, and Shell Fragments: A Validation Study

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The goal of this presentation is to provide empirical support and validity for physical matches of bone, shell and tooth fragments. It provides the first documented error rates for physical matches for this class of material.

This presentation will impact the forensic community and/or humanity by meeting *Daubert* guidelines for a commonly used forensic technique.

Physical matches are routinely used in forensic investigations as a way to confirm that two or more pieces of evidentiary material (*i.e.*, glass, paper, metal, paint, plastic, wood, tape, fabric) were originally one piece of material. Bone fragments are often physically matched in the reconstruction of skeletal elements as part of forensic anthropological examinations, as well as in paleoanthropological and archaeological contexts. Although routinely performed and widely regarded as intuitively evident, the reliability and validity of physically matching fragments of bone, and other mineral-based biological materials, has never been empirically tested. In academic contexts, this may be of little concern; however, in the forensic arena a well-designed study would be beneficial given the *Daubert* guidelines of scientific testing and documented error rates. This study examines the reliability and validity of physically matching bone, shell and tooth fragments. Differences between individuals with varying levels of experience with physical matching and osteology are also examined.

The specimens used included human bones (femur, tibia, fibula, parietal), non-human bones (long bones, vertebrae, mandible, plastron), non-human teeth, and shells. Specimens were fractured using a combination of static and dynamic loading until structural failure. Each of the resulting fragments used in the study were labeled with a randomly assigned number between one and one-hundred. The assigned numbers of all pairs of physically matching fragments were recorded.

A matching exercise that consisted of 57 fragments containing a total of 40 correct matches and six fragments with no possible matches was devised. The exercise was administered to individuals with varying levels of education, experience and training in osteology and physical matching, including forensic scientists and anthropologists. Participants were instructed to identify, and affix together with tape, all physical matches they believed to be present among the fragments. In addition, participants were asked to answer questions pertaining to their area of expertise, materials with which they have previous experience performing physical matches, any education or training in osteology, and criteria used to identify the matches. They were also asked to record the time required to complete the exercise. Exercises were scored as a function of correctly identified matches compared to the number of false positive matches (incorrectly affixing fragments that do not match) and false negative matches (failing to affix fragments that do match).

Preliminary results suggest that bone, tooth and shell fragments can be validly and reliably matched. No false positive matches have been identified by any participant. False negative matches are not uncommon, but do not appear to be related to the individual's experience level. Anthropologists who can draw on their knowledge of osteology to correctly identify, anatomically orient, and re-fit bone fragments may be at an advantage in complex cases, but even inexperienced individuals are able to locate and identify correct matches without incorrectly matching unassociated fragments.

Forensic Science, Forensic Anthropology, Physical Match

H101 Three-Dimensional Variation in Face Shape in a Large Study Sample

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After attending this presentation, attendees will gain basic understanding of the nature of face shape variation in 3D as measured empirically in a large study sample and its implications for forensic facial comparison from videotape, photographic, and other facial images.

This presentation will impact the forensic community and/or humanity through this first large empirical study of face shape variation in 3D undertaken using contemporary stereophotographic measuring techniques.

This paper will provide a summary of a study of face shape variation measured in three dimensions in a sample of over 3000 individuals collected in an eighteen month period from December 2003 to May 2005. A feasibility study will be briefly reviewed, which indicated that an anthropometric approach to face shape comparison in two- or three-dimensions using traditional craniofacial landmarks was plausible on the empirical grounds of density and visibility of the landmarks, particularly in areas of the face that it is commonly believed are variable between individuals—the shapes of the major facial features and the positional relationships between them. A student project examining face shape variation in two dimensions conducted in collaboration with Dr Nick Fieller of the Department of Probability and Statistics at the University of Sheffield, offered further confirmation of differences in positional relationships between landmark datasets in different individuals. A substantial proof-of-concept project was initiated involving a much larger sample of three-dimensional landmark data, which will form the core of this presentation.

The structure the collaborative research, between three University research groups—Sheffield, Nottingham and Kent at Canterbury, will be described. The process of ethical review and informed consent for the collection of 3D photographs of volunteer's faces for research in crime prevention and detection will be reviewed. Promotion of the project, with the support of the Magna Science Adventure Centre, near Rotherham, United Kingdom, will be described. In general, the museum visiting public were overwhelmingly well disposed to volunteer to be photographed in support of research in crime prevention detection. Methods used for collecting data from three-dimensional landmarks using a Geomatrix® stereophotographic scanner and FaceVision® software will be presented. A pilot study involving a sub-sample of thirty five faces landmarked at sixty sites in triplicate by two different observers offered measures of inter- and intra-observer error, and indications of landmarks that were relatively distinct in position between individuals, more or less subject to intra- or inter-observer error, and technically problematic with regard to establishing consistency in placement via a standard operating procedure. As a result of the pilot study, an optimal landmark set—based on accuracy and discriminating power—of thirty landmarks was chosen. This set of thirty three-dimensional landmarks was placed on a total sample of over 3000 individuals, in duplicate. A small comparative control dataset was collected manually using calipers and also using a Cyberware® 3030 RGB Head and Face scanner. Age, biological sex and ancestry distributions—all of which can affect face shape—will be discussed, especially in relation to the representativeness in an investigative context.

Our key findings with regard to the nature of face shape variation in 3D as assessed by the measurement of 30 landmark positions in duplicate in the sample of over 3000 individuals will be discussed. The distribution conformed to that of a multivariate normal model and normal distributions were indicated in pair-wise distance distributions assessed between paired landmarks. Landmark distributions between the most and least discriminating landmark pairs in the set of thirty will be described. The overall potential for the utility of three-dimensional landmarking in forensic face shape comparison will be discussed in relation to possible further research.

Facial, Variation, Comparison

H102 Facial Soft Tissue Depths in Craniofacial Identification: Properties Gleaned From a Comparative Bottom-Up Approach

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After attending this presentation, attendees will learn some history of soft tissue depth studies; and learn that traditional classifications of soft tissue depth data have little empirical statistical justification and are unnecessarily unwieldy. Attendees will retain or be able to implement new simplified average soft tissue depth data values for the face which have increased statistical power and advantages of standardization (one data table for adults and two for children, as opposed to the 50+ that currently exist).

This presentation will impact the forensic community and/or humanity by discussing the current soft tissue depth data available, their philosophical underpinnings and how they are used in practice by forensic artists.

Average soft tissue depths hold a central role in the craniofacial identification techniques of superimposition and approximation. Overall, many soft tissue depth studies have been published ($N > 50$) and large amounts of data have been collected ($> 153,000$ individual soft tissue measurements). The traditional perception, held since the origin of soft tissue depth investigations in the typological physical anthropology of the late 1800s and early 1900s, has been that meaningful differences in depths exist between particular human groups (e.g., by sex, age, and race). However, some group differences appear to be no larger than measurement errors (e.g., 1-2mm) indicating that these differences may be of much less significance than initially thought. An over-arching, large sampled, multivariate analysis would be the crucial test required to robustly elucidate group relationships; but in its absence some insight may be gleaned from a comprehensive comparative review of the vast number of mean values that have been published.

This study reviews the existing data means using a bottom-up comparative approach examining variables such as year of study, method of measurement, age (for children < 18 years), so-called race, and sex. The investigation demonstrates considerable overlaps between all groups, and (while not as powerful as a multivariate analysis) suggests that little information may be lost by pooling individual group data. These simplified statistical values, with increased statistical power, are presented for adults (one table) and children (two tables).

Forensic Science, Soft Tissue Thickness, Skeletal Identification

H103 Examination of Identification Methods Used by Medical Examiners: A Facility Study

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After attending this presentation, attendees will learn of the various categories of identifications made at Sparrow Hospital Forensic Pathology Section, Lansing, Michigan from a one year period.

This presentation will impact the forensic community and/or humanity by increasing awareness of the difficulties that arise when differentiating between positive and presumptive identification. The goals of this presentation are to discuss the necessity for a more solid understanding of the term "positive identification", and to introduce the prospects of another category of identification.

Positive identification is a somewhat loosely defined term that has been described in a number of different ways by scientists of varying backgrounds. Most would agree that positive identification is a scientific classification that compares known antemortem records with postmortem records of the deceased in order to determine whether or not they represent one and the same individual. This definition can be quite accurate for biological means of identification, such as fingerprinting, DNA, and comparative dental or medical radiography.

Presumptive identification, on the other hand, is defined as a nonscientific method that would "put either a likely or tentative name on a decedent, or at least put the decedent into a smaller subgroup" (Baker 2005). Both physical and non-physical characteristics, such as tattoos, scars, personal effects, location of body, and verbal testimony can be used to make the case for a tentative identification (Burns 1999). Many scientists would include in this category those identifications made by visual recognition.

Although the definitions of positive and presumptive, or biological and nonscientific, identifications are somewhat clear-cut, the cases that come into the medical examiner's office most often are not. Perhaps the current forensic definitions of 'positive' and 'presumptive' identifications are too simplistic to be applicable to the real world. Many factors impact the necessity for a more thorough investigation, such as whether a decedent was found within their own home, whether they were recognized by family members, and whether they exhibit a number of corresponding features. One question that is often asked is whether a very strong presumptive identification, with a preponderance of corresponding non-unique characteristics, can be considered a positive identification. If the answer is yes, then how many circumstantial points would add up to make a positive identification? If not, then should another category of identification be created to hold all classifications that are defined as neither positive nor presumptive? A third category, introduced in this paper, will be labeled "identification by multiple corresponding factors" and will include all identifications made by a multitude of non-scientific evidence, such as biological profile, location of body, tattoos, identification papers and others.

This study aimed to quantify the number of positive and presumptive identifications that were made in a one year period at the Sparrow Hospital Forensic Pathology Section in Lansing, Michigan. 796 cases from the year 2005 were reviewed and the type of identification was recorded and then placed into one of two corresponding categories: positive and presumptive. Biological identifications, such as fingerprints, DNA, and medical and dental radiographic comparisons were placed within the positive category, whereas identifications made through visual and multiple corresponding factors were placed within the presumptive category. Percentages were then calculated to determine what type of identifications were made the most.

Results indicate that the largest percentage of identifications were made visually. Of those identifications made visually, the vast majority

also included multiple corresponding factors, such as clothing, jewelry, and personal effects, etc. The second most common identifications were made through multiple corresponding factors. These identifications varied in strength depending on the number and quality of factors contributing to the identification. The next commonly made identifications were through dental radiographic comparison, followed by fingerprints, medical radiographic comparison, and finally DNA. This demonstrates that non-scientific means of identification were the most common and easiest obtained identifications. Despite the majority of non-scientific identifications, most would agree that all of these cases were identified, although the literature would state that they were presumptive.

In conclusion, these results indicate the necessity for a discussion about positive and presumptive identification. If the cases presented at the Sparrow Hospital Forensic Pathology Section in Lansing, Michigan are any indication of the kinds of identifications being made in medical examiner's offices across the country, then there is obvious necessity for more clear-cut definitions of positive and presumptive identifications, as well as the possibility of the introduction of a new category of identification.

Human Identification, Forensic Anthropology, Forensic Pathology

H104 The Technique of Sampling Skeletal Remains for Mitochondrial DNA Testing

Audrey L. Meehan, BGS, Joint POW/MIA Accounting Command/Central Identification Laboratory, 310 Worcester Avenue, Building 45, Hickam AFB, HI 96853*

After attending this presentation, attendees will understand the correct procedure and sampling areas for submitting skeletal remains for Mitochondrial DNA testing.

This presentation will impact the forensic community and/or humanity by demonstrating how mitochondrial DNA testing has proven to be a valuable tool in the identification of skeletal remains. Fragmented, weathered osseous material has been successfully sampled and sequenced providing a data base for comparison with family reference samples. The knowledge of how and where to sample the skeletal remains could benefit the general community to help resolve missing persons cases. It is proposed that the ME offices get their "skeletons out of the closet" and submit them for mtDNA testing for comparison with a maternal relative of the missing persons.

The mission of the Joint POW/MIA Accounting Command-Central Identification Laboratory (CIL) is to search for, recover and identify missing U.S. service personnel from past wars. Remains processed through the CIL include a wide range, from single individuals, such as the frozen WWII airman recovered from the mountains of California, to the commingled skeletal remains turned over by the North Koreans from former POW camps. Mitochondrial DNA testing has proven to be a very important tool in the identification of individuals represented by complete or fragmented skeletal remains. The sequence data generated also assists in the sorting of commingled remains from crash sites and mass burials. The CIL is currently at a submission rate of 900 osseous and dental samples per year. Contemporary missing person cases may also benefit from the data generated from the mtDNA testing of the skeletal remains. Self actuating samples are not necessary as results are compared to maternal relatives of the missing persons.

A minimum sample of two to five grams of concentrated cortical bone is necessary for processing osseous material for mtDNA. Each test uses two grams of sanded, cleaned bone which is ground to a powder prior to amplification. When presented with a complete, single set of skeletal remains, an aggressive sampling strategy is not necessary as a three square centimeter sample from any part of the femoral diaphysis will yield a minimum of 10 grams of cortical bone. However, the larger long bones which are preferred for sampling, are not always recovered, or as in

commingled remains, can not be associated with the skull or other recovered skeletal elements. Such cases require the utilization of optimal sampling areas. The choice of skeletal element is equally important when limiting the number of samples per case to be tested.

This presentation will discuss the sampling strategy developed for submitting osseous samples to the Armed Forces DNA Identification Lab (AFDIL) for mtDNA sequencing. It will also review sample contamination precautions and recommended equipment use.

Mitochondrial DNA, Missing Persons, Skeletal Remains

H105 DNA Preservation of Skeletal Elements From the World Trade Center Disaster: Some Recommendations for Mass Disaster Management

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After attending this presentation, attendees will learn which degraded skeletal elements recovered from a mass fatality incident are more likely to yield DNA for identification. Additionally, the authors will discuss management implications inherent in deciding which elements to sample for DNA identification.

This presentation will impact the forensic community and/or humanity by providing sampling protocol recommendations for forensic scientists/anthropologists who work in mass disaster identification.

When antemortem information is available, fingerprints and dental radiographs are more efficient than DNA for identifying intact victims. However, when antemortem information is not available or in cases of extreme body fragmentation, remains often can only be identified through DNA. Temperature, humidity, UV light, decomposition, soil microbes, fire, water, mold and other factors all contribute to the degradation of DNA in human tissue. Many studies have measured DNA degradation rates for bone and tissue subjected to heat, fire, water, burial in soil and time. Previous studies have also concluded that DNA degrades in different human organs at different rates, with liver and kidney tissue showing rapid degradation and brain tissue showing slow degradation. Additionally, research has demonstrated that bone preserves DNA better than soft tissue, since the structure of bone acts as a physical barrier to the external influences that can readily degrade soft tissue. Because the World Trade Center victim identification effort highlighted many of the confounding taphonomic factors that influence DNA preservation, the differential recovery rates of DNA between skeletal elements were examined.

DNA has been employed in disaster victim identification (DVI) for over 15 years. Initially, DNA was used as a last resort, usually when fingerprints, radiographs and dental records were not available. More recently, DNA has been used to reassociate larger, anatomically identifiable body parts, while smaller pieces were grouped as untestable common tissue. In 2000, DNA was first used as the sole method of identification for the 155 victims of the Kaprun cable car fire in Austria. Since then, the use of DNA has increasingly become the primary method of identification for victims of mass disasters and has become the most reliable method of reassociating even the smallest fragments. In any mass disaster, DNA sampling protocols have a ripple effect throughout the identification process, as small changes in these protocols may result in substantial savings in time and expense, and may greatly influence DNA identification rates.

Despite the prevalence of using DNA in DVI, the literature contains relatively little information regarding the variability in DNA identification success rates between different skeletal elements. Hence, little research has been conducted into which elements are most suitable for DNA

testing. Yet, choosing the most effective bone for sampling is crucial in the identification process. Anecdotal statements have suggested that long bone fragments, such as femur and tibia, are better for DNA sampling than cranial or rib fragments. However, these findings remain unconfirmed by DNA studies and are not supported by the present study. Using a subset of remains from the World Trade Center dataset, the variability in DNA identification rates between different skeletal elements were examined. The subset consists only of recovered bone fragments that were smaller than 4" and that were submitted in their entirety for nuclear DNA testing. Due to their size as well as the unique combination of taphonomic insults they had been subjected to, these remains are among the most challenging to identify from mass disaster sites.

Due to the unique nature of the World Trade Center disaster, it is proposed that the results of this examination represent a 'worst case scenario', which could be used to help establish sampling standards and protocols aimed at maximizing DNA identification rates from fragmented human remains. These recommendations are used to highlight potential challenges that undoubtedly arise during mass fatality incidents that involve severe fragmentation of remains.

Taphonomy, Skeletal Element, Mass Fatality Incident

H106 Considerations in Differentiating Negligence From Deliberate Misconduct — Lessons Learned From Tri-State Crematorium

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After attending this presentation, attendees will gain insight into considerations needed to differentiate negligence from deliberate misconduct when examining commingled cremains.

This presentation will impact the forensic community and/or humanity by providing insight into considerations that must be made when examining possible altered cremains in order to differentiate negligence from deliberate misconduct. The presentation will provide a better understanding of the north Georgia, Tri-State Crematorium case where over 300 remains were recovered in what is the largest, most complex case of its type in U.S. history. Findings from an excavation of Tri-State Crematorium's retort floor, in which archaeological excavation techniques were used, will be presented.

Forensic specialists are often called upon to verify the identification of cremated human remains when funeral homes or crematory facilities are believed to have accidentally released misidentified remains or intentionally substituted foreign materials. However, the funeral home industry's use of increasingly effective mechanical bone pulverizers following cremation has left physical anthropologists with fewer methods for determining the physical attributes of the remains. Thus, forensic specialists often rely on the recovery of unique personal artifacts such as fragments of medical or dental implements to confirm or refute the identity of remains.

On February 15, 2002, news began to surface of the many clandestinely placed bodies being found at the Tri-State Crematorium located in northern Georgia. A total of 339 bodies were reportedly recovered from the site in what is the nations largest crematorium related case. Based on work with the Tri-State Crematorium court case (Goins, Carpenter, James and Lockett law firm), this paper argues that unique, foreign inclusions do not always provide an adequate means of demonstrating deliberate misconduct or fraudulent activity on the part of a crematorium. Poorly maintained retort surfaces at some facilities may

result in negligent contamination through retention of remains and artifacts from previous occupants. These articles may be raked into future cremations, potentially resulting in questioned identity and accusations of misconduct.

Pertinent data related to this problem were gleaned from photographic documentation of the undisturbed Tri-State retort floor, archaeological excavation of the retort floor, and analysis and interpretation of findings. The Tri-State retort chamber measured 27 inches high by 36 inches wide by 96 inches deep, and was in a poor state of repair when initially examined. The fire bricks that composed the wall and ceiling were damaged and the floor had a loose sandy surface with a moist oily composition separated in places by fissures, depressions and pits. A cursory examination of the floor revealed numerous bones, teeth, screws, and other articles scattered throughout. Before the retort floor could be excavated, it was photographed in its undisturbed state. However, the restrictive 27 by 36 inch retort opening required construction and placement of a device to facilitate documentation without disturbing the floor. The device was constructed to support an aluminum beam for attachment of a camera, and for the later placement of a platform from which to work. The device would only contact the floor in four areas, each the size of a small screw head. A 35 mm digital camera was attached to the beam and overlapping photographs were made of the undisturbed floor, the walls and the ceiling over the length of the retort. The beam and camera were run along five paths from front to back of the retort floor with two photographs taken every 14 inches. These photographs were later juxtaposed to create a composite view of the retort floor.

After photographic documentation, a platform was then set in place above the floor to allow entry whereby the retort floor was diagrammed, and undisturbed articles were identified and collected. The retort floor was then grid into sixteen 12 by 18 inch units and excavated. The initial, loose surface was excavated by brush (i.e., all material loose enough to be removed by a brush) while a subsequent, deeper and more solid surface was excavated by trowel. Material from each grid unit and each depth was screened through two U.S.A. Standard Test Sieves, sorted and identified. A total of 4507.4 grams/3545.0 milliliters of excavated material was examined from the upper (loose) excavation, and 5952.2 grams/6875.0 milliliters from the lower (more solid) floor.

In support of the negligent contamination hypothesis, excavation of the crematory chamber yielded human bones and teeth, hair, dental appliances (e.g., porcelain crowns, gold-colored tooth crowns), possible surgical wire, snaps/fasteners, staples, wood screws, etc. Duplicate skeletal elements indicated a minimum number of two individuals although it is likely that a larger number of individuals was represented among these bones and teeth. Due to irregularities in the poorly maintained retort floor, these articles were missed by the flat metal rake used to remove remains. In addition, a greater concentration of articles was found near the back wall of the chamber, an area more difficult to reach with the rake.

Finally, of the crematory operators surveyed, 10 of 13 responded that minor inclusions from previous cremations were possible, even in modern facilities. Thus, if John Doe had no teeth yet his urn contains a tooth fragment, it should not be concluded that the urn does not contain the remains of John Doe.

Although Tri-State provides an extreme example of facility neglect and mismanagement, it clearly illustrates the need for forensic scientists who are asked to testify in such cases to familiarize themselves with the type of retort used, method used for removal of remains from the vault, and the history of maintenance for the retort surface. Such knowledge is critical in differentiating negligence from deliberate misconduct when examining commingled cremains.

Cremains, Tri-State Crematorium, Forensic Anthropology

H107 The Donation Dilemma: Academic Ethics and Public Participation at the Anthropological Research Facility

Bridget Algee-Hewitt, MA, Rebecca J Wilson, MA, and Lee Meadows Jantz, PhD, University of Tennessee, 250 South Stadium Hall, Knoxville, TN 37996*

After attending this presentation, attendees will have a better understanding of the unique ethical issues facing the Forensic Anthropology Center at the University of Tennessee, so that they can effectively disseminate information about the body donation program and promote the growth of similar programs.

This presentation will impact the forensic community and/or humanity by better informing fellow forensic anthropologists of both the more practical issues facing FAC, as well as, the program specific obstacles that are challenging but professionally stimulating. It is the hope that with this knowledge and open forum of information, that the profession can more effectively propose a resolution, be it in the classroom or the professional environment.

A panel discussion at the 2006 Seattle, WA AAFS meetings addressed, for the first time, the personal and professional issues facing forensic anthropologists in light of greater public participation. It is the purpose of this paper to address specifically these issues as they affect the Forensic Anthropology Center at the University of Tennessee, as a unique program that marries both a personal relationship with living donors and an academic interest in the skeletal remains.

One need look no farther than popular culture in order to grasp the recent ubiquity of public exposure to and mainstream interest in the forensic sciences. Despite drastically oversimplifying the scientific challenges facing forensic anthropologists, representations of the forensic sciences in popular culture nevertheless have generated an external interest in the academic study of human remains. The body donation program at the University of Tennessee is undoubtedly the best example of a positive site of interaction between this growing public awareness of and appreciation for forensic anthropology and the rigorous scientific and academic understanding of the processes of death, decay and population variation. While this manifestation of the "CSI effect" is helpful in increasing interest in the donation process and acceptance of the research conducted at "The Body Farm", the work at the Anthropological Research Facility (ARF), as a scientifically rigorous and academically valid endeavor is, in consequence, necessarily complicated. The Forensic Anthropology Center (FAC) and its body donation program, as a unique institution within the field of forensic anthropology, removes the scientific issues surrounding death from a laboratory setting and relocates them within the public context of living donors and grieving families. The questions that remain to be resolved, in addition to the scientific objects of investigation, are the practical, personal and ethical dilemmas that accompany the constructed relationship among the forensic anthropologists, the medical and legal communities and, most importantly, the social network that supports the program itself.

The ARF at the University of Tennessee has grown to serve not only as a temporary repository for unidentified remains, but also as the intermediary resting place for the individuals donated through the body donation program. While the donation program ensures the continuing addition of the human remains necessary for research at the ARF and has provided an unprecedented diversity of modern skeletal materials for the William M Bass collection, its combined scholarly and public nature, particularly when coupled with its recent popularity, requires the anthropologists working at the FAC to operate outside of the traditional roles of an academic program. Whereas a typical forensic anthropologist focuses exclusively on the rigorous scientific investigation of individual remains in either a law enforcement or academic setting, those working with the donation program at the University of Tennessee must serve in a variety of disparate and often non-traditional capacities: as liaisons with

the public in order to accurately and effectively educate prospective donors about the realities of the program; as funerary consultants for those contemplating donation in their final arrangements; as grief councilors who must ensure a high level of respect in their treatment of the donor's remains and who must also communicate this respect to the grieving families; and, finally, as scientists and progressive academics whose responsibility to the donor lies in making full use of his or her remains to advance the knowledge of the field. To these forensic anthropologists, therefore, the donor is both a numbered object of scientific study and a named individual, who, over the course of contact with the program, make the transition from living to deceased. The tensions between these irreconcilable positions are not traditionally covered in any scholarly program within the field; yet maintaining these positions is necessary to ensure the continuing success of the FAC. The University of Tennessee's body donation program therefore provides a unique site of interaction between the public and academic pressures of the discipline of forensic anthropology and the ways in which these tensions are changing in the face of mounting public interest, both positive and negative. It is this changing face of the discipline as specifically located in the academic, popular and ethical responsibilities of those anthropologists working with the body donation program at the University of Tennessee that this paper proposes to examine.

It is the intention of this discussion to better inform fellow forensic anthropologists of both the more practical issues facing FAC, as well as, the program specific obstacles that are challenging but professionally stimulating. It is the hope that with this knowledge and open forum of information that the profession can more effectively propose resolution, be it in the classroom or the professional environment.

Anthropological Research Facility, Body Donation, Ethics

H108 *Daubert* and *Kumho*: Implications for Anthropologists in the Courtroom

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After attending this presentation, attendees will understand the *Daubert* and *Kumho* Supreme Court decisions regarding expert witness testimony and their impact on forensic anthropological testimony.

This presentation will impact the forensic community and/or humanity by raising the issue as to what type of anthropological testimony falls under the *Daubert* and *Kumho* standards, and whether trying to fit certain anthropological techniques into a strict framework is appropriate.

Within the last fifteen years, the Supreme Court of the United States has implemented major changes concerning the admittance of expert testimony in federal cases, which has forced the modification of rule 702 regarding expert testimony in the Federal Rules of Evidence. Two significant judicial decisions have catalyzed these revisions. Previous to 1993, under the *Frye* Rule, courts admitted scientific expert testimony if the technique that formed the basis of the testimony was generally accepted as reliable by the relevant scientific community. However, in 1993 the Supreme Court of the United States passed down the landmark decision *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, based on its interpretation of the Federal Rules of Evidence. This decision superceded the *Frye* Rule and stated that judges were the ultimate authority in questions about the admissibility of expert testimony. It also established four guidelines for judges in determining the admissibility of expert testimony: the content of the testimony is testable and has been tested using the scientific method, the technique or theory used in the testimony has been subject to peer review, the technique used in the testimony has a known or potential error rate, and that the technique or theory has established standards and is generally accepted by the relevant scientific

community. These guidelines became known as the *Daubert* standard, and forced a reexamination of scientific testimony. Significantly, in 1999 the Supreme Court passed down a lesser known, but equally important, decision *Kumho Tire Company, Ltd. v. Carmichael* in an effort to clear up some misconceptions from the earlier *Daubert* ruling. This decision established that experts may develop theories based on observations and then apply those theories to the case before the court, as is done in technical expert testimony. In addition, the Supreme Court also established that all four *Daubert* standards are not applicable to every type of expert testimony, but the same rigor that is applied to scientific testimony must also be applied to technical testimony. Thus, *Kumho* does not supercede but works in tandem with *Daubert*, and it is the duty of the judge to determine under which standard the testimony should be held. Although these decisions refer only to federal cases, many states have followed suit while others are continuing to move towards applying these changes.

Questions still remain as to how these decisions have impacted expert testimony in general, including anthropological testimony. Many recent forensic publications have stressed the importance of developing anthropological techniques to meet *Daubert* standards and have attempted to do so, but none to date have discussed the significance of the *Kumho* ruling. Physical anthropology has never been defined as a pure science, and nothing is preventing some types of anthropological testimony from being admitted as technical expert testimony, as many other scientific disciplines have recognized. While many anthropological techniques, such as sexing and aging, with definable error rates meet *Daubert* standards, other techniques such as taphonomic assessment are more of a technical skill relying on observation and experience rather than empirical testing. However, such observations are still admissible under the *Kumho* standard. Exactly where other techniques that are commonly used by forensic anthropologists fall, such as those used in radiological identifications, is less clear. Recent publications have attempted to modify these techniques to meet *Daubert* standards without considering that they could still be admissible under the *Kumho* standard, similar to testimony by forensic pathologists. By trying to force such techniques into the category of scientific rather than technical testimony, these publications may be trying to meet inappropriate standards, especially since the admissibility of these techniques has not yet been questioned in court. In addition, the rigidity required by *Daubert* may inadvertently lessen the power of these methods by imposing unnecessary limits to their use. Although the admissibility of expert testimony has become stricter, the *Kumho* standard allows that technical anthropological techniques properly performed do not necessarily need to meet stiffer standards.

Forensic Anthropology, Expert Witness Testimony, *Daubert* and *Kumho* Rulings

H109 Bones of Contention - The Investigation of a Cadaver Dog Handler

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After attending this presentation, attendees will understand methods to process and compare large scale cases involving numerous submissions (over 2700 bones were submitted). They will also learn about a significant case that affected many in the forensic community.

This presentation will impact the forensic community and/or humanity by showing the importance of testing and certification for all dog handlers working for law enforcement organizations. It will also emphasize the importance of creating formalized training programs which

will utilize law enforcement personnel from within police agencies as canine handlers rather than relying on private individuals who cannot be closely regulated. This case and presentation may impact the way that all dog handlers interact with the forensic community in the future.

This presentation will discuss the investigation of a well known cadaver dog handler who was accused of planting bones and other evidence at various crime scenes. The suspect in the case had provided her services to state, local, and federal law enforcement organizations all across the United States and in other countries for many years working on hundreds of cases. She and her K-9 companion were renowned for finding skeletal material, blood, and other human materials even when those who had searched before her had come up empty handed.

Over the years, several individuals from various law enforcement organizations believed they saw the handler throw down skeletal materials at crime scenes; however, nothing was ever proven and they themselves often dismissed it by thinking that they just misunderstood her actions. Eventually, the handler went out on a crime scene search in Michigan to look for the body of a missing girl. The search resulted in the handler finding fourteen human bones, which were eventually submitted to the FBI Laboratory for mitochondrial DNA analysis. Four of the bones were selected randomly for examination. All four of the bones were determined to have different mitochondrial DNA types, and all of them were different than the type of the victim. At this point, it was still unclear if the handler was involved in any suspicious activity. Authorities may have stumbled across the dumping ground of a serial killer, and if this was the case, a more thorough search of the area needed to take place. A second search was conducted using the same dog handler; and this time, a forensic examiner from the crime laboratory witnessed her pulling a bone from her sock and plunging it into a creek bed. This launched a large-scale investigation of the handler which involved the cooperation of many different police and governmental agencies. Everyone that the handler had conducted searches for in the past was contacted, and items of evidence that she had recovered at crime scenes were sent in to the FBI Laboratory for examination and comparison to bones and other human material found in the handler's residence and vehicle. The handler had gotten human materials from many different individuals such as dentists, medical examiners, anthropologists, and other dog handlers. She had also given human materials to many other cadaver dog handlers. All of these people were questioned, and materials associated to the handler being investigated were obtained for comparison to skeletal material found on the various searches she conducted. In total, well over 2700 items of evidence were submitted to the laboratory for examination which required a joint effort utilizing anthropology, trace evidence, mitochondrial DNA and nuclear DNA to and analyze and compare the materials.

A detailed discussion of the events leading up to the investigation, the analysis of the evidence submitted in the case, the laboratory findings, and the eventual outcome of the investigation will all be presented.

Bones, Dog, Cadaver



I1 Multidisciplinary Session: Head and Brain Trauma

Joseph N. Kenan, MD, and Daniel A. Martell, PhD, Park Dietz & Associates, 537 Newport Center Drive, Suite 200, Newport Beach, CA 92660; William Bernet, MD*, Psychiatric Hospital at Vanderbilt, 1601 23rd Avenue, South, Nashville, TN 37212; Laura L. Liptai, PhD*, BioMedical Forensics, 1660 School Street, #103, Moraga, CA 94556; Mary E.S. Case, MD*, 6039 Helen Avenue, St. Louis, MO 63134; and Elaine Whitfield Sharp, JD*, Whitfield, Sharp & Sharp, 196 Atlantic Avenue, Marblehead, MA 01945*

After attending this presentation, attendees will have an understanding of different disciplines evaluate traumatic brain injury for the legal system.

This presentation will impact the forensic community and/or humanity by providing the bio-pathological, engineering, psychiatric, and legal aspects of traumatic brain injury cases.

Members from the psychiatry section will present information on the psychiatric component of subtle TBI cases. Dan Martell, MD will present the research on the psychiatric aspects of TBI. Questions he will address include: What does research show about a person who has a bump on the head, but no loss of consciousness? Is there any plausible way that such a person would have significant symptoms? William Bernet, MD, will discuss the principles for the forensic psychiatric evaluation of individuals who are describing emotional and cognitive symptoms following a head injury. Brief clinical vignettes will illustrate the three principles (thoroughness, moderate skepticism) and consideration of the differential diagnosis for the symptoms presented.

Laura L. Liptai, PhD, will present the Bio-Medical Engineer's unique role in head injury analysis, and will provide a wide variety of examples that illustrate the methods used to quantify the head/brain trauma sustained and calculate the statistical probability of injury. The Federal Standardized bases for this methodology will also be presented.

Mary E.S. Case, MD, Pathology/Biology, will discuss the forensic neuropathology issues in the area of traumatic brain injury at the level of concussion and mild diffuse axonal injury and present several cases illustrating these issues. Common forensic neuropathology issues include how to determine pathologically when loss of consciousness occurs in traumatic diffuse axonal injury, the pathological findings in common sports injuries and second impact syndrome, and how to detect and evaluate fictitious concussive head injury.

Elaine Whitfield Sharp, JD, will present a plain-English synopsis of the standards for the admissibility of scientific testimony in state and federal courts by explaining the principles of *Daubert* and *Frye*, and how these apply to testimony and to medical literature proffered as scientific in the area of TBI. For reference, a handout will include main holdings of the law of scientific evidence and will include a bibliography of books, treatises, and articles helpful in evaluating the scientific validity of medical and forensic literature.

Brain, Injury, Trauma

I2 Child Murderer: Psychiatric & Legal Assessment

Gagan Dhaliwal, MD, 608 Davis Circle, Huntsville, AL 35801; and Sarghi Sharma, MD*, 301 University Boulevard, Route No. 186, Galveston, TX 77555*

The goals of this presentation are to describe children accused of murder and to describe psychiatric and social factors along with psychological underpinnings of this phenomenon; to define the concept of risk assessment in children charged with murder; and to discuss the use of PCL-YV in risk assessment of juveniles charged with murder.

This presentation will impact the forensic community and/or humanity by enhancing knowledge regarding children accused of murder and the role of psychopathy and other risk factors in context of risk assessment.

Forensic psychiatrists are often retained to evaluate children charged with murder. Risk assessment for future violence can be one of the objectives of these evaluations. Child and Forensic psychiatrists due to their expertise in child and forensic psychiatry can use their training and experience to provide psychiatric and risk assessments in these children. However, risk assessment in children is a relatively young field that requires additional research and professional direction.

The paper will address aspects of psychiatric and risk assessment of children charged with murder. Common psychiatric symptomatology and psychological underpinnings that explain the motives of these children will be discussed based on clinical vignettes. Due to confidentiality reasons, the discussion will focus on salient legal and psychiatric points, instead of details of each case. Furthermore, role of psychiatric pathology, substance abuse, prior sexual/physical abuse, relationship with parents/care providers, academic achievement, social skills, handling of anger/frustration, role models will be discussed along with other risk factors of future dangerousness. Aspects of forensic report writing and testimony in juvenile and criminal courts, in context of risk assessment in children will also be addressed.

Use of Juvenile psychopathic traits based on Psychopathic Checklist - Youth Version (PCL-YV) can provide additional information in these evaluations. However, concept of juvenile psychopathy has raised questions about its validity due to difficulty in diagnosing children and adolescents with personality disorders. Therefore concept of juvenile psychopathy will be defined and its predictive potential about response to rehabilitative attempts in children and future dangerousness will be specifically addressed.

Child Murderer, Risk Assessment, Juvenile Psychopathy

I3 Adolescent Neonaticide: Psychiatric and Legal Perspectives

Gagan Dhaliwal, MD, 608 Davis Circle, Huntsville, AL 35801;
Stephen B. Billick, MD*, 11 East 68 Street, 1-B, New York, NY 10021;
and Neil S. Kaye, MD*, 5301 Limestone Road, Suite 103, Wilmington,
DE 19808*

After attending this presentation, attendees will understand the psychiatric and legal aspects of adolescents' infanticide; how the legal system and society deals with adolescent neonaticide; the role of denial of pregnancy, increased passivity tendencies, dissociation, and panic in infanticide, and the role of a forensic psychiatrist as well as interaction with media and the legal system; and the prevention of neonaticide through use of safe haven laws, adoption, abortion, and considering psychiatric, developmental and social factors.

This presentation will impact the forensic community and/or humanity by enhancing the knowledge of adolescent neonaticide by describing the role of forensic mental professionals and how the legal system and society deal with adolescent neonaticide.

Gagan Dhaliwal, MD, will discuss the public health and epidemiological aspects of neonaticide. Dr. Dhaliwal will describe how the justice system has resolved some of these cases and summarize society's reactions to these crimes. Implications of absence of a neonaticide defense in United States will be discussed. He will also discuss preventive aspects of neonaticide among adolescents, including use of adoption, controversial abortion, and "Safe haven legislation" that allows a mother to drop her baby at a hospital or a designated area.

Stephen B. Billick, MD, will present aspects of clinical and forensic evaluation of an adolescent charged with neonaticide. Dr. Billick will describe common psychiatric symptomatology and psychological underpinnings that can explain the motives for this illegal act, including increased likelihood of passivity, social isolation, immaturity, denial of pregnancy, and brief psychosis.

Neil Kaye, MD, will discuss specific roles of a forensic psychiatrist in neonaticide cases including dealing with attorneys and media. Dr. Kaye will describe use of neonaticide syndrome defense, men's rea defense, and ways to assess culpability and insanity. Specific aspects of forensic report writing and testimony regarding neonaticide will be discussed as well.

Adolescent Neonaticide, Denial of Pregnancy, Safe Haven Laws

I4 The Past, Present, and Future of Police Psychology in the New York Police Department

Gregory I. Mack, PhD, John Jay College of Criminal Justice,
445 West 59th Street, Psychology Department, New York, NY 10019*

After attending this presentation, attendees will be better informed about the nature and sources of work-related stress within the NYPD. The attendee will be able to consider the anticipated long-term health and mental health consequences of the 9/11 terrorist attacks and the enduring threat of terrorism in New York.

This presentation will impact the forensic community and/or humanity by serving as a point of further discussion among professionals involved in providing services to and within the law enforcement community. This presentation will also assist in the identification and adequate consideration of environmental factors impacting upon police performance.

Research in several domains provides clear evidence of an association between stress and health. Stress response theory describes a process in which various bodily systems including the heart and blood vessels, immune system, digestive system, the sensory organs, and the brain activate to meet the challenges of a perceived threat or stressor¹. A

stressor can be internal or external, acute or chronic. An acute stressor such as the recollection of a threatening situation can cause an immediate stress "fight or flight" response. A chronic stressor such as loneliness is a more enduring condition. As such, the desire to fight or run away must be suppressed. Studies indicate that people who report having high levels of stress also report significantly more physical and mental health problems. Daily hassles along with acute and chronic stress contribute to overall poor health and psychological distress in a complex manner. Consistent with these findings, individuals who work in high stress occupations also evidence significantly more health problems, sleep disturbance, substance abuse, and are at greater risk for premature mortality.

There is a large body of research on the stressful nature of police work. Researchers have consistently stated that police work is one of the most stressful occupations. Experts in the field have identified three main sources of police stress: operational stressors, organizational stressors, and work-family conflict². Operational stressors include exposure to dangerous and traumatic critical incidents, sustained risk of serious physical injury or death, and negative interactions with the public. Organizational stressors include poor interpersonal relationships with supervisors, shift work, excessive and redundant administrative tasks, and a lack of recognition for heroic actions. Work-family conflicts identify an officer's perception of increased work stress due to the job's negative affect on his family. For example, an officer's husband might experience increased anxiety due to his concerns about his wife's safety while she is working on an undercover assignment. This in turn leads to the officer perceiving her work as more stressful. The cumulative effect of daily hassles, critical incidents, and chronic stressors coupled with destructive rather than constructive coping strategies contribute to police officers experiencing significantly more stress-related illnesses than workers in other occupations³. Police officers evidence higher rates of cardiovascular disease, cancer, and hypertensive heart disease⁴. Police stress can make the officer vulnerable to other adverse health symptoms including asthma, allergies, and migraine headaches. Police work-related stress also precipitates psychological disturbances such as emotional dysregulation, depression, posttraumatic stress disorder and other psychological sequella⁵.

The stress of police work has increased dramatically since the attack on the World Trade Center. These stress levels are steadily increasing. The recent death of veteran first responders from ailments that many believe were the result of inhaling toxic dust at ground zero and the landfill, and the growing health concerns of police officers similarly exposed supports this contention. Added to this psychological quagmire is the general feeling that government officials have abandoned "heroes." This is evidenced by complaints of lack of adequate medical resources and post 9/11 federal funds, money that was supposed to pay for the medical monitoring of first responders, now being used by local government to fight disability claims in court⁶.

Dr. Mack, a Detective Specialist and a licensed clinical/police psychologist with 19 years of experience in the NYPD, will provide an overview of past and current police stress, as well as the anticipated stressors that New York police officers will likely face in the near future. Particular attention will be focused on the psychological impact of the 9/11 terrorist attacks, the persistent threat of terrorism in New York, and the war in the Middle East. The presentation will also provide information on successful stress management initiatives and offer recommendations for future practice and research within the field of police psychology.

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Police Stress, Police Psychology, Stress Response

15 Consideration of Parental Mental Illness in Child Custody Recommendations

Brittany N. Dudas, MD, MPH, and Nicole Foubister, MD*, New York University School of Medicine, 100 Centre Street, Room 500, New York, NY 10013; and Stephen B. Billick, MD, New York Medical College, 11 East 68th Street, Suite 1B, New York, NY 10021*

After attending this presentation, attendees will understand the various issues involved in assessing the role of mental illness in parenting ability.

This presentation will impact the forensic community and/or humanity by assisting the forensic community to be better able to help judges in their determination of child custody for children with parents who have mental illness.

The evaluation of the parent's mental illness is important in determining the parental choice for custody in child forensic cases. The parents can have psychotic illnesses, non-psychotic illnesses (depression, anxiety, hypochondriasis, etc), personality disorders, and substance use and abuse disorders. It is important to evaluate the severity of the illness in the parent and the impact of the illness on the parent's activities of daily living. The evaluator needs to evaluate if the illness affects the capacity for caring for the child, and the capacity of the parent for caring for themselves. The assessment should include an evaluation of the parent's treatment compliance and the importance regarding the child's care. Along with compliance, the evaluator needs to assess the illness stability and the frequency of breakthrough exacerbations. Finally the evaluator needs to assess the child's understanding of the parent's illness and the capacity of the child to cope with the parent.

Child Custody, Mental Illness, Children's Capacity

16 Scientific Advances in Understanding Child and Adolescent Brain Development and Its Applications in the Legal Realm: From Barring the Executions of Juvenile Offenders to the Individual Forensic Pediatric-Psychiatric Evaluations

Manuel Lopez-Leon, MD, New York City Health and Hospitals Corporation, North Brooklyn Medical Associates, 338 1st Avenue, New York, NY 10009*

The goal of this presentation is to examine the recent break-through research that supports scientifically the argument that adolescent brains are different than the brains of mature adults. This information was used

by various medical societies in their *amicus briefs* sent to the Supreme Court in support of the abolition of capital punishment in adolescents when arguing the *Roper v. Simmons* case.

This presentation will impact the forensic community and/or humanity by creating awareness of the recent scientific research that has provided insight into understanding brain development in children and adolescents. It will also create awareness that this information has implications in the legal arena as used by legislators to justify legal decisions. The scientific research also has clinical implications when doing forensic psychiatric evaluations in children and adolescents.

This presentation will also provide insight into the existing research in adolescent brain development and how this information is relevant when doing forensic pediatric-psychiatric evaluations. This information intends to clarify the evaluation of criminal responsibility, and premeditated versus impulsive violence.

Research shows that adolescents tend to rely more on instinctual structures, such as the amygdala, and less on the more advanced areas of the brain, such as the frontal lobes. They also lack fast routes for thoughts to travel and control emotions. This predisposes them to impulsive acts. However, why aren't all adolescents violent? What is the difference between impulsive violent behaviors and premeditated behaviors when forming a forensic opinion?

Juvenile Offenders, Capital Punishment, Forensic Pediatric-Psychiatric Evaluations

17 Issues of Suicide and Tokophobia During Pregnancy

Ariel L. Troncoso, MD, and Kaushal K. Sharma, MD, USC Institute of Psychiatry, Law, and Behavior, PO Box 86125, Los Angeles, CA 90086-0125*

After attending this presentation, attendees will learn how pregnancy maybe a suicidal risk factor that can occur early in the first trimester of pregnancy. Tokophobia (fear of pregnancy) is a risk factor along with the psychological, physiological changes during the first trimester. These changes can trigger suicide most commonly by overdose. In obvious causes of death, the reproductive organs are not routinely examined hence suicide during pregnancy may well be under reported.

This presentation will impact the forensic community and/or humanity by increasing awareness that pregnancy is not a psychologically protected time in a woman's life. The first trimester of pregnancy can be as lethal as the third trimester or even the postpartum period up to a year. The prevalence of first trimester pregnancy can vary from 0.02% to 0.02% depending on whether or not the reproductive organs are examined. In completed autopsies, the incidence is higher, 0.2%. So, incidence of early suicide in pregnant women is under estimated.

Pregnancy in general, is considered a protective time in a woman's life. However, pregnancy might worsen psychiatric illness at that time. That is, the pregnant woman might be psychiatrically at risk as medications are reduced or removed during the first trimester, and or the circumstances of the pregnancy might contribute to significant stresses, both physically and psychologically. One contributing illness might be tokophobia (fear of pregnancy). As a consequence, the risk of suicide cannot be overlooked.

All suicidal ideation does not necessarily lead to completed suicide. Usually the focus of suicide in the pregnant woman is during the third trimester and the postpartum period (up to one year after birth). However the knowledge and experience of a woman being pregnant at any time during her gestation, may add stress on multiple levels.

Death from suicide in the year after childbirth is considered the leading cause of maternal death. However, during the first trimester, tokophobia may play a significant role. Suicide during early pregnancy

may be related to issues of avoiding embarrassment, perceived ridicule, scorn of being pregnant or having an unwanted pregnancy. Physical issues such as nausea, vomiting, and other complications may be stressors that place a pregnant woman at risk for suicidal behavior.

Completed suicide during pregnancy and up to one year up to 0.2%. In many Coroner's /Medical Examiner's offices after childbirth, have a statistical prevalence range of 0.02% including the Los Angeles Coroner's office, the reproductive organs may not routinely be examined at autopsy unless there is reason to believe that the decedent was pregnant. Thus, current statistics may certainly be an under estimate of the prevalence of 1st trimester suicides.

In those published studies from Coroner's /Medical Examiner's Offices, where pregnancy was determined, the most common method of suicide was a drug overdose rather than the use of aggressive means such as firearms.

Suicide, Pregnancy, Tokophobia

18 Forensic Aspects of Body Dysmorphic Disorder in the Context of Informed Consent

Ariel L. Troncoso, MD, and Kaushal K. Sharma, MD, USC Institute of Psychiatry, Law, and Behavior, PO Box 86125, Los Angeles, CA 90086-0125*

After attending this presentation, attendees will Those who practice cosmetic, bariatric, dermatological surgery that alter body image with their procedures would include informed consent for possible Body Dysmorphic Disorder as well as screen for it using the three questions: (1) Does the individual spend excessive time concerned over this defect where it interferes with normal activities on the job, school, or home? (2) Is the defect exaggerated when in fact, to most persons, only minimal? (3) Does the individual constantly check the defect and experience emotional pain from the defect and avoids mirrors, shiny surfaces, and tries to camouflage the defect? If it is answered, "yes" to any one of these three questions, then there is cause for concern that the individual may have BDD and be referred to a mental health professional. Since the 1995 Norman Hugo appellate decision, it is incumbent that surgeons screen for this possibility.

This presentation will impact the forensic community and/or humanity by demonstrating how disorder with a high rate of depression, suicidal ideation, and suicide attempts. Most informed consent for surgeries that modify body image such as cosmetic, dermatological, bariatric procedures that add three questions that would service both the surgeon's informed consent requirement and screen for a serious comorbid disorder, BDD with prompt referral for mental health assessment and treatment.

Body Dysmorphic Disorder (BDD) is an uncommonly discussed psychiatric illness in cosmetic, bariatric, dermatological surgical settings. For patients who are seeking such procedures, the BDD diagnosis can be more easily ascertained if three questions are added to the informed consent document: 1) does the individual spend excessive time concerned over this defect to the point where it interferes with normal activities on the job, school or home?; 2) is the defect exaggerated and in reality only minimal in appearance to most people?; 3) does this individual constantly checks the defect and experience emotional pain, and avoids mirrors or deliberately camouflages the defect? If the patient answers "yes" to one of these questions he may have BDD and a referral to a mental health professional should be considered for further interview, psycho education, psychotherapy (Cognitive Behavioral Therapy), and possible pharmacotherapy.

The well-publicized case of Dr. Norman Hugo leads to an appellate decision in 1995 stimulated professional attention to a formerly less discussed disorder. The original contention of the malpractice lawsuit

was a lack of informed consent, specifically with regard to identifying possible BDD in his cosmetic surgery patient.

The incident rate of BDD in the DSM (Diagnostic and Statistical Manual) varies by the context of the sample and the expertise of the data collector. The prevalence rate of BDD may be as high as 1 to 2 % in the general population, to as high as 10 to 20% in an average dermatological practice.

In individuals suffering from BDD, they show increased co morbidity for various psychiatric disorders including a high rate of suicidal behavior. As high as 20% of patients with BDD, experience suicidal ideation, and a reported 7 to 23% have attempted suicide in their lifetime. Other serious psychiatric disorders that are co morbid with BDD include Major Depression, which is recurrent, with and without suicidal ideation, acute delusional disorder, or delusions of reference. These co morbidities add to the postoperative dissatisfaction, and repeated procedures such as in the Norman Hugo case, that lead to increased dissatisfaction and despair.

The problem cosmetic, bariatric, and dermatologic surgeons are presented with is how to obtain meaningful informed consent from a pathologically disordered patient who believes his/her perceived defect is "real" but in fact minimal. Thus anytime body image is being altered surgically, and then the possibility of BDD should be part of the informed consent. The three above added questions could help complete informed consent and also identify the BDD patient who will not benefit from the proposed procedures.

Informed Consent, Body Dysmorphic Disorder, Body Image Modification Procedures

19 Losing Your Rights: Complications of Misdiagnosis

Richard G. Rappaport, MD, 7401 Via De Fortuna, La Costa, CA 92009-6936*

The goal of this presentation is to assist experts and particularly physicians to realize that the recording of preliminary diagnosis and opinions can have lasting and adverse effects on patients or companies and that there is prejudice against those who do not play along with the institutions involved.

This presentation will impact the forensic community and/or humanity by assisting in the recognition of the severe consequences that may occur from misdiagnosing a patient, and by dispersing the learned material into the various institutions one may encounter, including hospitals, the police, and the courts. Anti -psychiatric attitudes prevail which require preventive measures similar to those taken when other experts contest corporate issues in biased cases.

Violation of civil rights, forced treatment and commitment under the guise of psychiatric care are depicted in two cases involving female physicians who became "patients" in non-medical situations in different States. They were each violently victimized and at some point in their cases acted in pro per.

In both cases these women were denounced in court as malingerers after a (mis)diagnosis of psychosis and dangerousness was used to justify police action, incarceration, restraint and forced injections of psychotropic drugs to incapacitate them.

In addition, this author's role as a forensic psychiatrist and expert witness in each of these cases was markedly handicapped by the court's prosecutorial favoritism and prejudicial attitude against such "mentally ill" persons. The specific effects of the many injustices in these very similar cases was to negate the freedom of these women, to violate their civil rights and to discredit psychiatry while justifying the court's and police powers.

Misdiagnosis, Violations, Civil Rights

I10 General Consensus Module: Unified Profiling System

*Richard S. Stewart**, *Criminal Justice/Forensic Sciences, American Intercontinental University, Dunwoody Campus, 6600 Embassy Row, Atlanta, GA 30328*

After attending this presentation, attendees will gain an understanding of the General Consensus Module (GCM) unified system of profiling for serial pattern offenders. This synopsis will present a step by step process, but bear in mind that this is a summary and many more factors and variables will go into the creation of the overall system. Profiling is a relatively new and growing field that will become one of the most useful tools for law enforcement personal to identify the most likely candidates for serial pattern criminal acts, both within the system and those who have not yet been found out.

This presentation will impact the forensic community and/or humanity through the behavioral sciences fields, though this system encompasses numerous disciplines and methods across the board. The unified system allows for input from criminal investigators, criminologists, forensic scientists, psychology/psychiatry fields, criminal profilers, and mathematics and even other smaller but not less important aspects of investigations.

The system itself entails the process from the crime to the pre-screening process to the profile makeup and profile output to the possible suspect pool (both known and unknown) to the notification of authorities to the apprehension of the suspect to the study of the suspect for further analysis and then returning the analyzed data to the system database for preventing, understanding and recognizing future serial pattern offenders. This system would be a comprehensive unified effort among those who are involved with serial pattern offenses allowing them to pool their resources together to achieve an efficient and thorough profile of an offender from many points of view. The system itself will comprise of all five forms of profiling while using both inductive and deductive logistical reasoning. Then using a network of those with relevant expertise, a comprehensive profile can be built of a suspect that is both thorough and without skepticism. This profile would then encompass all commonalities and unique traits that have been discovered by all who are profiling each and every case with unusual circumstances. This will create commonalities and acceptance across the fields in the science of criminal justice allowing for a more accepted range of generalities within the scientific communities.

This, as anyone in the field would know, would go a long way with use of profiling in a legal context. All the while making society safer from these predators by eventually comprising a characteristic and trait database for the recognition of future offenders and thus being able to possibly monitor those who are at risk and then seeing where the stressors occur that could potentially thrust one over the mental edge and then doing all that is possible to prevent them, if at all possible to begin with.

This GMC will hopefully impact behavioral sciences as well as all areas of law enforcement as an effective and irreplaceable tool in the investigative formats. Hopefully the GCM will further the field of criminal/behavioral profiling as an accepted science and others within the field will see its value as a system that is long overdue within the sciences of criminal justice by creating a networking system that crosses over all disciplines.

Serial, Profiling, Database

I11 *Jus Primae Noctis*: Psychological Analysis of a Perpetrator's Strategy and Behavior

Biagio Solarino, MD, MDS, and Giancarlo Di Vella, MD, MDS, PhD, Section of Legale Medicine, University of Bari, Piazza G. Cesare, Policino, Bari, 70125, Italy; Isabella Berlingiero, PhD, Roberto Catanesi, MD, MDS, PhD, and Ignazio Grattagliano, PhD, Section of Criminology and Forensic Psychiatry, University of Bari, Piazza G. Cesare, Policino, Bari, 70125, Italy*

After attending this presentation, attendees will have a general understanding of the peculiar behaviors found in one intra-familial perpetrator of child sexual abuse, evaluated in a rural area of south Italy.

This presentation will impact the forensic community and/or humanity by providing insight into the psychological evaluation of a perpetrator's role in intra-familial incest and sexual aggression. The goal of the present work is to highlight a peculiar strategy employed by the offender who used an unbelievable connection between myth, ritualism, magic, and other cultural traditions to induce his young daughter into a sexual relationship with him. The study of social background factors, coupled with the mental subterfuge used by sexual abusers, requires a rigorous scientific approach and should be studied case by case in order to gain valid information regarding the internal psychological world of such offenders.

The *jus primae noctis* (law of the first night/*droit du seigneur*) was, in the late European Medieval period, a widespread popular belief in an ancient privilege of the lord of a manor to share the bed with his peasants' newlywed brides on their wedding nights.

Father-daughter incest is the most traumatic type of childhood abuse; independent surveys estimate a rise in it although, in Italy as elsewhere, data collection methods and the reluctance of victims to disclose abuse contribute to an underestimation of such crimes.

Hence, incest is not only a subtype of sexual child abuse. As well as *Jus Primae Noctis* represents a symbolic gesture of male power display, coercive social dominance provided by the father who uses his power position against his child who has very limited power.

This is a case presentation of an incest victim who was raped by her father during a four-year period. She was 16 years old when she first disclosed the abuse with the help of her boyfriend. The authors were introduced to this case via a court-ordered evaluation of the 17-year-old victim for competency to testify in a courtroom. The Forensic Psychiatric team at the University of Bari is routinely consulted in a wide variety of child abuse and neglect cases, which include the examination of the perpetrator for diminished capacity and criminal responsibility, as well as the victim's competency to testify against him.

This case occurred in Calabria, a region located in southwest Italy, were many rural areas are strongly influenced by popular beliefs, myths, superstitions, and cultural traditions.

Her father first sexually approached the victim when she was twelve years old, in a moment in which he shifted roles from being a protector to becoming a seducer. It is important to note that anyone's first sexual experience may represent a way of coming to know their own sexuality, as well as a means of breaking away from the family context. For this reason the victim's father was worried about possible future sexual intercourse with a boyfriend, so he convinced his daughter that it was normal to have her first sexual intercourse with her own father, in order to affirm his sexual supremacy over her. He felt that he had to teach her something about the male sex and began showing her stories and drawings depicting genitals and sexual acts, followed by fondling and genital touching. The mother and brother were not aware of the abuse. The father often drugged his wife with sleeping pills in order to avoid being discovered while having sexual relations with their daughter. The perpetrator had vaginal, oral, and anal intercourse with the young daughter whenever the mother was knocked-out.

At times he watched pornography and afterward forced the girl into sodomy. At the age of 14, she spurned the father's sexual advances. He convinced her that this behavior was a consequence of "the evil eye," and called a black magician who persuaded the daughter to endure anal sexual acts with her father and drink his seminal fluid in order to eliminate this malaise.

The perpetrator's strategy in father-daughter incest, as illustrated in this case report, is rarely reported and evaluated in connection with the context in which it occurred.

The reporting of similar cases will likely promote further psychological enlightenment and understanding of this type of abuse.

Incest, Child Abuse, *Jus Primae Noctis*

I12 Basic Addiction Medicine for the Forensic Scientist

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After attending this presentation, attendees will understand how substance use disorders are common among the criminal offending population. Up to 80 per cent of the incarcerated adult American population, and arrests, are associated with substance abuse. Strong risk factors for violence include substance abuse, especially with comorbid psychiatric disorders. Continued substance abuse is predictive of a high rate of criminal recidivism. Therefore, understanding basic mechanisms of chemical dependency, their presentation, detection, treatment and relationship to re-offending, is critical in treating and rehabilitating a criminal population. At the conclusion of this panel discussion, the participant will be able to understand: 1) the basic epidemiology and neurobiology of substance use disorders, and their relationship to violence; 2) presentation of chemical dependency, detection and intervention in the adult criminal population; and 3) basic psychotherapeutic, psychopharmacologic and rehabilitation treatment modalities in offending populations.

This presentation will impact the forensic community and/or humanity by increasing the understanding of basic mechanisms of chemical dependency, their presentation, detection, treatment, and relationship to re-offending, is critical in treating and rehabilitating a criminal population.

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Addiction Medicine, Forensic Psychiatry, Substance Abuse

I13 An Analysis of a Large Sample of North American Suicide by Cop Cases

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After attending this presentation, attendees will gain an understanding of the prevalence, dynamics, outcomes, risks, characteristics, and identifiers of suicide by cop among officer involved shooting cases. Recognizing that suicide by cop is a unique method of suicide that occurs at a significant rate among officer involved shooting cases. This large study has significant implications for those in forensic practice.

Suicide by cop occurs at a high rate among officer involved shootings. The use of deadly force is often litigated civilly and can also result in criminal prosecution of the subject, as well as the officer. This presentation will impact the forensic community and/or humanity by demonstrating how understanding the latest research, as derived by this study-to date the largest empirical study of suicide by cop-is essential to those offering forensic psychological or psychiatric opinions.

This presentation provides an overview of a very unique threat faced by law enforcement: subjects who engage in behavior designed to provoke their violent death at the hands of police. Past studies indicate that up to 25% of all police shootings involve individuals who are suicidal yet engage in actions that pose or appear to pose a threat to others as they seek to commit suicide. Characteristics of suicidal individuals are discussed, and the unique dynamics of those who choose suicide by cop as their method of self-destruction will be highlighted, including the different types and motivations of such subjects. A particular emphasis will be on the dangerousness of such individuals and the overlap and parallels between homicidal and suicidal impulses. New data from a large sample of North American police shootings will be shared as it relates to this phenomenon. This data addresses the factors specifically associated with this threat potential. Coroners, medical examiners, police officers, detectives, attorneys, and mental health professionals will find this presentation informative in many ways-from helping to recognize situations that might pose such a threat to post event investigations and forensic proceedings.

Suicide By Cop, Officer Involved Shootings, Subject Precipitated Death

I14 On Pins and Needles: Manner of Death When an Unusual Form of Self-Mutilation Leads to Fatal Consequences

Baiyang Xu, MD, Marissa L. Feeney, MD, Dwayne A. Wolf, MD, PhD, and Luis A. Sanchez, MD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will be aware of an unusual death resulting from chronic self-insertion of metallic foreign bodies into various parts of the body ultimately leading to an intrathoracic abscess; determination of the manner of death in this case, in the context of her psychiatric disorders, will be discussed. Also included will be a more general review of common forms of self-injurious behavior and the role of psychiatric illness in the determination of manner of death.

This presentation will impact the forensic community and/or humanity by addressing the dilemma in determining the manner of death in a decedent that has a history of psychiatric illness with a rare form of self-mutilatory behavior superimposed on a background of suicidal ideation and numerous suicidal gestures/attempts.

The decedent was a 48-year-old white woman with a history of bipolar disorder, schizophrenia, prescription medication abuse and numerous suicide attempts by consuming pills or engaging in self-destructive behavior. The decedent's surgical history included a thoracotomy for treatment of a punctured lung with pneumothorax approximately six years prior to her death and a laparotomy for treatment of a self-inflicted stab wound of the abdomen one year prior to her death. The day before her death, the decedent visited her primary care physician for difficulty breathing. She was diagnosed with pneumonia and started on antibiotics. The next day her spouse found her unresponsive in bed at home, where she was pronounced dead. Numerous loose pills and prescription medication bottles were in a nightstand drawer next to the bed.

Externally, the decedent had numerous linear and irregular, hypopigmented scars on the neck, upper chest, abdomen, flexor, and radial surfaces of the forearms, dorsal hands, and anterior thighs. Internally, thin, cylindrical metallic white, yellow, and brown foreign bodies ranging from 0.4 to 5.1 centimeters long and up to 0.1 centimeters in diameter were in the upper chest and mediastinal soft tissues, upper and middle lobes of the lungs, right lobe of the liver, left flank, and right pelvis; these objects included sewing needles, broken hypodermic needles, and a fragment of yellow wire. The foreign objects were variously oxidized and were frequently surrounded by fibrous tissue. The thoracic cavity had marked mediastinal, pericardial, and pleural adhesions with fibrotic pleural plaques. A hemorrhagic abscess, approximately 10 centimeters, involved the upper right lung and superior mediastinum with extension into the right atrial appendage and aorta. The right pleural cavity contained approximately 100 milliliters of cloudy fluid. Marked adhesions and patchy scarring were over the right lobe of the liver.

The cause of death was "intrathoracic abscess due to self-insertion of metallic foreign bodies into torso." The decedent did have a history of multiple suicide attempts, but subsequent interview with her spouse revealed that she had been engaging in this specific form of self-mutilatory behavior for many years. Although ultimately producing a fatal complication, her actions were not specifically intended to cause death; thus, the manner was classified as an accident.

Both men and women with various psychiatric disorders exhibit self-mutilatory behaviors, but the majority of those who self-mutilate are women with borderline personality disorder. The most common forms of self-injurious behavior include: cutting, biting, or scratching oneself until the skin is broken and bleeds; picking healing wounds until they re-bleed; pulling hair or nails; head banging; bruising oneself; burning the skin with heat, chemicals, or cigarettes; and refusing to take prescribed

medications. Remote self-inflicted incised wounds often show typical characteristics and are usually noticeably uniform, thin, linear scars arranged in parallel on body surfaces that are within easy reach (radial and flexor surfaces of the forearms, anterior torso, and anterior thighs). Self-insertion of metallic foreign objects under the skin is a rare but previously reported form of self-mutilatory behavior⁵.

Differentiation between suicidal and self-mutilatory behaviors is often difficult and is usually based on three characteristics: lethality, repetition, and ideation or intent. First, methods of self-mutilation tend to be of low lethality with physical damage ranging from superficial to moderate¹. Second, self-mutilation tends to be a more repetitive behavior than suicide attempts². Finally, only a small minority of individuals report suicidal ideation or intent at the time of self-mutilatory behavior^{2,4}.

References:

¹ Favazza AR, Conterio K (1989), Female habitual self-mutilators. *Acta Psychiatr Scand* 79:283-289

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³ Lloyd E, Keeley ML, Hope T (1997), Self-mutilation in a community sample of adolescents: descriptive characteristics and provisional prevalence rates. Poster presented at the Society of behavioral Medicine, New Orleans, March 17

⁴ Walsh BW, Rosen PM (1988), *Self-mutilation: Theory, Research, and Treatment*. New York: Guilford

⁵ Penn VJ, Esposito LC (2003), Suicide attempts, and self-mutilative behavior in a juvenile correctional facility. *Journal of American Academy of Child and Adolescent Psychiatry* 42: 7

Self-Mutilation, Manner of Death, Psychiatric Illness

I15 Firearms and the Mentally Ill: Demographics and Psychiatric Characteristics of Individuals Petitioning for Early Relief From Firearms Prohibition

Joseph R. Simpson, MD, PhD, and Kaushal K. Sharma, MD, USC Institute of Psychiatry and Law, PO Box 86125, Los Angeles, CA 90086-0125*

After attending this presentation, attendees will have learned about the weaknesses of the current national background check system for firearms purchases, the incidence of firearms prohibition on grounds of involuntary commitment in California, the demographics and psychiatric characteristics of a sample of individuals who petitioned for relief from this prohibition, and the internal and external factors correlated with the granting or denial of the petition. They will also learn about the potential negative impact of an involuntary hold in terms of employment and the need for input by forensic experts in judicial determinations involving firearms possession issues.

This presentation will impact the forensic community and/or humanity by describing the impact of clinical decisions on firearms possession, pointing out the opportunities for expert witness input in the adjudication of firearms prohibition relief petitions in California and around the nation, and pointing out the weaknesses in the national background check system with regards to the purchase of firearms by individuals with a mental health history.

California law provides for stringent regulation of the possession of firearms by individuals with a history of mental health treatment. Any person who is placed on a 72-hour involuntary hold for observation on the grounds of danger to self or others and admitted to a psychiatric ward is subject to a five-year prohibition on the possession of weapons including all firearms. Each month the California Department of Justice

receives notice of thousands of individuals who have been placed on 72-hour holds. Some of those who thus lose the ability to legally possess firearms had no psychiatric history prior to the index 72-hour hold. Of these, some are employed, or wish to be employed, in fields that require a firearms permit, e.g., law enforcement or private security. Thus, placing someone on an involuntary hold for convenience when it is not clinically necessary (as may happen when a patient is ambivalent about admission but at the moment of consultation agrees to voluntary hospitalization) may have unanticipated consequences for the patient's livelihood.

California law also provides an opportunity to petition, once in the five-year period, for early relief from the prohibition. There has been no systematic investigation of the characteristics of individuals making these petitions or of the outcomes of these legal actions. Significantly, California law does not require the input of a mental health expert in the decision, but leaves it to the discretion of the judge of the superior court in the county where the petitioner resides. In some states, restoration of the right to possess firearms is dependent on certification by a physician that the individual no longer presents a danger as a result of mental illness. Typically this is the patient's treating psychiatrist. No state currently requires examination by an independent forensic expert in the restoration process.

This presentation will review California laws governing possession of firearms by individuals with a mental health history, contrasting these laws with federal laws and the laws of other states. The mechanics of the national background check mandated by the federal Brady Handgun Violence Prevention Act of 1993 as it pertains to individuals with a history of mental health commitment will be examined. Upwards of four million firearms transactions take place in the U.S. each year, but important weaknesses in the background check system remain. Finally, the demographic and mental health data of a sample of individuals petitioning for early relief in Los Angeles County and the results of their petitions will be discussed.

Clinicians who place individuals on involuntary holds should familiarize themselves with the firearms laws of their jurisdiction and avoid the unnecessary forfeiture of their patients' right to possess firearms. Psychiatrists and psychologists who provide expert witness services have the potential to improve the quality of the analysis performed in proceedings where an individual is seeking the overturning of a prohibition on firearms ownership. The addition of expert testimony in such proceedings would likely reduce the number of unnecessary denials of petitions for relief, while simultaneously reducing the number of individuals who appear safe to the untrained judicial eye, but in fact pose an unacceptable risk. Clinicians and forensic experts alike should be aware of the limitations of the current national background check system for firearms purchases.

Firearms, Involuntary Hospitalization, Expert Witness

I16 An Introduction to Rational Emotive Behavior Therapy for Forensic Mental Health Clinicians

Richard Rosner, MD, Forensic Psychiatry Clinic, 100 Centre Street, Suite 500, New York, NY 10013

After attending this presentation, attendees will understand the basic theory of Rational Emotive Behavior Therapy (REBT) the first Cognitive Behavioral Therapy in the field of evidence-based mental health treatment, the core elements of the practice of REBT as a therapeutic method, and how to obtain formal training in REBT.

This presentation will impact the forensic community and/or humanity by making more widely known, and more potentially available, an evidence-based mental health treatment, Rational Emotive Behavior Therapy (REBT). REBT is a relatively cost-effective

psychotherapeutic method, which is of special value to forensic mental health clinicians working in the juvenile and adult correctional systems.

Rational Emotive Behavior Therapy (REBT) is a form of Cognitive Behavior Therapy (CBT) an evidence-based psychotherapy. REBT is relatively easy for practitioners to learn, relatively easy for patients to be taught, and it produces relatively rapid symptomatic improvement (in comparison to psychoanalysis and psycho-analytically-oriented psychotherapy). It is of particular interest to forensic mental health clinicians in juvenile and adult correctional settings because it is a relatively cost-effective psychotherapeutic method. This presentation will describe the theoretical framework of REBT, the elements of its therapeutic method, and information about how to obtain formal training in REBT.

Evidence-Based Medicine, Psychotherapy, Corrections

I17 Civil Commitment and Criminality: The Fine Line Between Inpatient Treatment for Dangerousness and Criminality

Sanjay M. Sahgal, MD, USC Keck School of Medicine, 3940 Laurel Canyon Boulevard, #411, Studio City, CA 91604; and Adam M. Weisman, PhD*, and Kaushal K. Sharma, MD*, USC Institute of Psychiatry and Law, PO Box 86125, Los Angeles, CA 90086*

After attending this presentation, attendees will have learned about civil commitment laws in psychiatric inpatient practice and the poignant legal situations that arise when a criminal act is alleged against an inpatient on an involuntary hold. Forensic consultations regarding these issues will be understood more completely.

This presentation will impact the forensic community and/or humanity by addressing a challenging situation that forensic mental health professions encounter during the course of their consultations with attorneys and judges. An understanding of the issues presented can enhance the value of the input forensic evaluators can offer to the legal community.

In the State of California, under the Lanterman-Petris-Short Act, acute mentally ill individuals may be civilly committed to an inpatient treatment facility if they present as a danger to self, a danger to others, or gravely disabled. Such involuntary holds are subject to administrative review within 72 hours and judicial review in the case of extended hospitalization with similar criteria. In the case of individuals in danger to self or others, treatment facilities often continue to assess risk to self or others as a standard protocol. However, when dangerousness to others is expressed during the civil commitment, treatment providers are perplexed as to whether to handle the matter as an expression of the patient's decompensation or a criminal act leading to removal of the patient to jail in order to face criminal charges.

To better understand this issue, two psychiatric-criminal cases are presented. In each case, the defendant was civilly committed to an inpatient facility as a danger to self or others. In each case, the defendant struck out against another individual. In the first case, the victim was a psychiatric nurse attempting to medicate the defendant during an episode of acute agitation. In the second case, the victim was a fellow patient standing outside the defendant's room. Both patients were arrested and charged with assault. Each case was referred for a forensic evaluation as part of a legal defense strategy. Each attorney has used the strategy, that their client assaulted someone as an act of a mental illness.

Each case will be presented in detail, including the relevant social and psychiatric history and psycho-legal disposition. In exploring the nuances of these poignant situations, the forensic psychiatric and psychological issues that arise within the criminal justice system when patients are formally charged will be presented.

Two important questions arise from the cases: Is a person legally culpable for his violent acts when civilly committed for dangerousness to others? To what degree do such violent acts represent a treatment and containment responsibility on the part of the psychiatric inpatient team?

It will become clear from the presentations that there is significant ambiguity in both the civil commitment laws and the criminal code with respect to culpability in such matters. An understanding of the nuances of these situations will give the forensic mental health professional greater flexibility in assisting the courts during proceedings relating to these matters.

Aggression, Criminal Issues, Civil Commitment

I18 Automating a Reliable System for Distinguishing Real From Simulated Threat Letters

Carole E. Chaski, PhD, Institute for Linguistic Evidence, Inc., 25100 Trinity Drive, Georgetown, DE 19947*

After attending this presentation, attendees will have learned about a highly reliable, validated method for distinguishing between real versus simulated threat letters and threat letters versus angry letters.

This presentation will impact the forensic community and/or humanity by demonstrating how to handle threatening communications in terms of duty to warn and duty to protect.

The ability to distinguish between real threat letters and simulated threat letters is important in both law enforcement and psychiatric scenarios. When law enforcement is faced with a situation in which threatening letters have been received, the responding detective must first determine whether the threat is real or not. This determination enables the law enforcement agency to make most efficient use of its work force in determining how much protection the victim requires. When a psychiatrist, psychologist or social worker is faced with a situation in which a patient or client has written a threatening letter, the psychiatrist, psychologist or social worker must determine whether the ethical duty to warn applies, because the threat is real, or not. Chaski (1997) collected simulated threat letters from over 100 writers. Chaski, Howald, and Parker (2006) reported the results of an experiment in which Howald blindly evaluated 100 documents for the presence or absence of twenty-two linguistic features related to threatening communication. The 100 documents contained real threats, which were obtained from Chaski's and others' case files, simulated threats and angry letters from Chaski's Writer Sample Database. The 100 documents were randomized and divided into four sets. Based on Howald's evaluation, SPSS 13's CRT procedure (Classification and Regression Tree) obtained as high as 97% accuracy at distinguishing real from simulated threats. The reliability of the system is demonstrated by the fact that these high results were obtained even under cross-validation. Since human evaluation may vary depending on the coder, this linguistic-feature system would be most useful if it were automatized or semi-automatized in a computer software system. This talk presents the results of automating the threat assessment system, so that law enforcement or psychiatrists can simply use a computer program to provide a threat assessment.

Threat Assessment, Duty-to-Warn, Computational System

I19 Risk Factors For Adolescent Violence: A Retrospective Study

Waqar Waheed, MD, University of Calgary, 113 9th Street NW, Calgary, Alberta T2N 1T1, Canada*

After attending this presentation, attendees will enhance their understanding of static and dynamic risk factors associated with adolescent violence; learn of approaches to assessment of violence risk in adolescents; and understand potential risk factors to target as foci for primary intervention strategies.

This presentation will impact the forensic community and/or humanity by highlighting risk factors for adolescent violence, which are foci for intervention and emphasize the potential benefit of primary prevention strategies.

Violence among youths is an important public health problem. Between 1985 and 1991, homicide rates among youths 15-19 years of age increased 154% and remain, today, at high levels. Previous research points to a number of factors that increase the probability of violence during adolescence and young adulthood. Some of these factors include the early onset of aggressive behavior in childhood, social problem-solving skill deficits, exposure to violence, poor parenting practices and family functioning, negative peer influences, access to firearms, and neighborhoods characterized by high rates of poverty, family disruption, and social isolation.

Variations in social cognition serve as one possible mechanism by which these environmental experiences influence aggressive behavior during adolescence. Children who have been maltreated tend to display negatively biased social-cognitive processing styles, which may in turn increase their likelihood of reacting aggressively in ambiguous social situations. Similarly, witnessing community violence is associated with aspects of social cognition, including beliefs that support aggressive responses to threat.

Major risk factors for violence include gender and deviant behaviors, such as using and selling drugs, committing nonviolent felonies, and engaging in other forms of nonviolent delinquency. Low academic orientation, lack of parental affection and support, and perceptions of parents' substance use also show strong links with violent behavior. As the number of risk factors increases, so does the likelihood of engaging in violent behavior. Boys and girls show somewhat different paths to violence, with girls being comparatively more susceptible to the effects of family problems or disruption and impaired relationships with parents. For boys, engaging in other deviant behaviors provides the most information about their propensity to commit violent acts. Weak bonds with school and family also have an impact on serious violence for boys.

Boys who have repeated one or more grades are more likely than those who have not to be at high risk for violence perpetration. For both girls and boys with a history of grade repetition, predictive risk factors include violence perpetration, violence victimization, weapon carrying, school problems, and alcohol and marijuana use. School connectedness, parent-family connectedness, high grade point average, and emotional well-being have been identified as significant universal protectors against violence perpetration. For both girls and boys there were substantial reductions in the percentage of youth involved in violence in the presence of protective factors, even with significant risk factors present. Violent events involving preadolescent and early adolescent girls are more likely to be in response to a previous event and to involve the home environment and family member intervention.

In relationships characterized by both sexual intercourse and violence, sexual intercourse is significantly more likely to precede violence rather than the reverse, regardless of type of violent act. Adolescent sibling violence is a predictor for college dating violence. Males have reported experiencing more sibling violence than females, but females have reported experiencing more dating violence, both as perpetrators and victims.

Currently, there is an emphasis on providing violence prevention programs in the school environment, typically with little parental or caregiver involvement. The most influential risk factors (i.e., the family, community, and peers) have their principle impact on youth aggression outside the school.

The presentation will describe a non-experimental retrospective study involving a population of adolescents referred by the New York County Court system to the Forensic Psychiatry Clinic for forensic evaluation (excluding fitness to stand trial evaluations). This study will demonstrate the relationship between the presence of psychiatric illness or substance use with violent crimes by adolescents.

Adolescence, Violence, Risk Assessment

I20 Andrea Yates Did Not Have Postpartum Psychosis

Sheila C. Wendler, MD, John A. Burns School of Medicine, University of Hawaii at Manoa, 345 Queen Street, Suite 900, Honolulu, Hawaii 96813*

After attending this presentation, attendees will understand the history and current status of the concept of postpartum psychosis; appreciate the importance of reliance on appropriate source of evidence when conducting a forensic evaluation; and recognize that reliance on proper sources of evidence offers no support for the proposition that Andrea Yates suffered from postpartum psychosis at the time of her offenses.

This presentation will impact the forensic community and/or humanity by counteracting the deleterious public and professional impact of the news media in the case of Andrea Yates.

A careful analysis of the forensic evidence developed in the case of *Texas v. Andrea Yates* demonstrates that her diagnosis does not meet the diagnostic criteria for postpartum psychosis, a diagnosis which has been essentially endorsed by the American Psychiatric Association and promulgated widely by the media.

When Andrea Yates drowned her five children on June 20, 2001, her story attracted national attention. A great amount of conjecture about her mental condition has been published since then, not only in lay publications, but also in the scientific literature.

Unfortunately, considerable misinformation about the case was published in Margaret Spinelli's "Maternal Infanticide Associated With Mental Illness: Prevention and the Promise of Saved Lives", to which the American Psychiatric Association (APA) drew a great deal of scientific and public attention by selecting as the 2004 Manfred Guttmacher awardee. In her Guttmacher Award address Dr. Spinelli asserted that Andrea Yates suffered from postpartum psychosis at the time of her offenses.

However, in discussing the case and making public a diagnosis of Mrs. Yates, Dr. Spinelli relied largely on inaccurate media reports. She disregarded such forensic evidence as crime scene evidence bearing on Mrs. Yates' mental condition, and observations and interviews of the defendant by law enforcement personnel on the day of the offense. The overall effect of Dr. Spinelli's speaking and writing has been to misinform the public, and to discredit the forensic process in psychiatry by her reliance on a grossly flawed method of study.

The presenter was a psychiatric consultant to the Harris County District Attorney's office prior to and during the Yates second trial, and observed in this capacity the presentation of all evidence at Mrs. Yates' second trial. She also had full access to medical records, police reports, court transcripts, videotaped interviews of Mrs. Yates, and other evidentiary materials pertaining to both the first and second trial.

Andrea Yates, Postpartum Psychosis, Standards of Forensic Evidence

I21 Psychopathology and Weapon Choice: A Study of 103 Perpetrators of Homicide or Attempted Homicide

Giuseppe Troccoli, MD, Sezione di Criminologia e Psichiatria Forense - University of Bari, Italy, Largo Giordano Bruno, 65, Bari, Italy 70121, Italy; Roberto Catanesi, MD, and Chiara Candelli, MD, Sezione di Criminologia - University of Bari, Italy, Policlinico - Piazza Giulio Cesare, Bari, Italy 70124, Italy*

The goal of this study is to identify some correlations between factors associated to the crime scene (choice of weapon, place, time, and so on), and the mental status of a perpetrator at the time of the crime. The analysis of over a hundred perpetrators and crime scenes, with a specific focus on the choice of weapon, motivation and psychiatric disorders at the time of the crime, have revealed some relevant trends and correlations that could suggest a close interaction between these issues, sometimes with an identifiable and recurrent pattern of findings.

This presentation will impact the forensic community and/or humanity by demonstrating a broad application of the results of the study in various fields including psychiatry, psychology, criminology, and others. This study will hopefully stimulate further research in this area.

The study evaluated 103 perpetrators of homicide or attempted homicide at the request of either the courts or prosecutors, when a mental disorder was suspected. As a result, these cases do not reflect homicides associated with criminal activity.

The aim of this study was to ascertain a relationship between weapon choice and psychopathology, as well as a correlation to the degree of acquaintance between perpetrators and victims.

The perpetrators were evaluated at the Department of Criminology and Forensic Psychiatry of the University of Bari in southern Italy. Psychiatric examination and Psycho-diagnostic tests were administered for each of the perpetrators. A data base was subsequently formulated, which included information pertaining to age, sex, prior convictions, psychiatric history, substance abuse, crime location, time which crime occurred, weapon used, number of hits, sites, and types of lesion, as well as behavior at the time of the crime. The data base also included information pertaining to behavior before and after the crime, psychopathological disorders, precipitating factors, and information about the victim and the victim's relationship with the perpetrator.

The results showed a prevalence of male perpetrators (about 85%) with a mean age primarily in the adult and elder range, while women tended to be young adults (age: 18-24). Substance abuse was present in 16.6% of all cases, with alcohol being the most commonly used substance at the time of the crime (72.2% of all substances).

In the majority of cases, the crime scene was a house or an apartment, usually belonging to either the perpetrator or victim. In addition, the perpetrator and victim were usually acquaintances. The victim was in the most of cases an acquaintance (29%), followed by husband/wife or co-habiting partner (18.2%), children (13.2%), stranger (12.3%), other relative (11.5%), father/mother (10%), friend (3.3%), non co-habiting partner (2.5%).

The most frequently identified psychiatric disorders at the time of the crime were equally distributed between psychotic disorders (23.3%) and personality disorders (23.3%). In both of these categories, the trend of weapon use was almost identical, where knives were most often used, followed by a variety of other weapons. In cases where a personality disorder was diagnosed (23.3%), it was mostly that of cluster B (16.5%). No cases involving cluster C were identified.

In cases of delusional disorders (11.6%), which was the other most common psychiatric condition seen in this study, knives were the weapon of choice, followed by firearms. No other types of weapon were used in this category.

Other psychiatric conditions were those related to Mental Retardation (8.7%).

In 7.8% of cases no psychiatric pathology was identified, and in the same percentage of cases the condition identified was an impulsive reaction.

When depression was present in the perpetrator (6.8%), the crime scenes tended to be "cleaner," because mostly suffocation, poisoning, or precipitation was involved. In these cases the perpetrators tended to be young mothers who killed their children at a very young age, and it was rare that a traditional weapon was used.

The other conditions, which have emerged from this study, were of the organic type (5.8%), substance abuse (2.9%), and bipolar disorders (2%).

With regard to the apparent motivation, delusional persecution was most common (27.2%), followed by impulsive reaction (21.3%), no apparent motivation (15.5%), jealousy (13.5%) and other less frequent categories. When the crime was motivated by jealousy, a knife or a firearm was most often used. In these cases, when pathological (2.9%) or delusional jealousy (4.8%) was present, the outcome of the aggression was either murder or attempted murder, whereas in cases where the jealousy was not of a pathological or delusional nature (5.8), the outcome was exclusively murder.

With respect to non-conventional weapons, which were rarely used, stones were most used in cases where no psychiatric condition was identified, always resulting in homicide. Other non-conventional weapons included poison and fire. At times a car was used as a weapon, motivated by delusional persecution. The least used weapon was a hammer, or a cane.

Weapon Choice, Homicide, Psychopathology

122 The Role of Fantasy in Sexual Offending

Karen M. Pepper, BS, and Patrick N. McGrain, PhD, DeSales University, 2755 Station Avenue, Center Valley, PA 18034*

After attending this presentation, attendees will understand the role of sexual fantasy in the causation of deviant sexual behavior is not as strong as presented in the literature.

This presentation will impact the forensic community and/or humanity by demonstrating how clinicians should reassess the general assumption in the treatment of sexual offenders that fantasy plays a causative role in sexually deviant behavior.

Theories in both criminal justice and psychology have stressed the importance of sexual fantasy both in the development of sexual offenders and as a component of their offenses. However, despite their acknowledged importance, there have been relatively few investigations of the actual content and evolution of these fantasies and their effect on the offense cycle of the offender. In the present study, ten convicted sexual offenders in an outpatient treatment program were interviewed to gain insight into the origin, content, and evolution of their sexual fantasies. A qualitative analysis of their responses yielded insight into the creation and motivations of sexual deviance.

Fantasy, Sexual Offending, Qualitative Analysis

123 My Space or Yours? Issue of Consent in the Age of Cybersexuality

Risa B. Grand, MD, Kaushal K. Sharma, MD, and Mark Jaffe, MD, USC Institute of Psychiatry, Law and Behavioral Science, PO Box 86125, Los Angeles, CA 90086-0125*

After attending this presentation, attendees will gain an enhanced understanding and awareness of the conflicts and issues of consent by minors in Internet-related sexual activity.

This presentation will impact the forensic community and/or humanity by demonstrating how this is an important issue that has a significant impact on the fields of forensic psychiatry and psychology for cases involving minors or adult sex offenders. Criminal activity involving relationships established on Internet communities like MySpace.com is increasingly common.

The popularity of Internet "communities" is rising exponentially. In 2006, MySpace.com, a social networking website, boasts 68 million members. Because such sites do not require age verification, there are no accurate estimates of the number of minors accessing their "space." However, as individuals who regularly interact with junior high or high school age adolescents can attest to, the popularity of MySpace.com and similar sites in this population is enormous. Therefore, it is reasonable to assume that a large number of users are minors. Although MySpace.com advises its members that they need to be at least 14-years-old to use their site, there is no way for the site to enforce this policy. There are many minors who have postings that indicate they are younger than 14-years-old.

American youth are typically more adept at utilizing text messages, instant messages, and other electronic technology than most adults. According to the 2005 Census, there are over 17 million minors aged 14 through 17 living in the United States. The National Telecommunications and Information Administration reports that 75.6% of minors in this age range use the Internet. While this high-tech literacy confers some advantages, it also exposes many young people to unregulated sites where they can potentially interact with adults who can easily misrepresent their age, income, occupation, and social and marital status. In recent years there are increasing reports in news media announcing the arrest of adults who met underage (or presumed underage) minors through Internet communities.

The widespread use of this relatively new technology and the potential for it to lead to criminal activity and harmful behavior are important issues that now face forensic psychiatry. Primary among these are issues of consent. Age of consent is defined as the age in which persons are bound to their words and acts. Most states in the U.S. limit the age under which parties can get married by requiring that people be at least 18 years of age or legally emancipated minors. Inferred from this law, society believes that a person must be of a certain age to be physically, emotionally, and cognitively mature enough to enter into a marital or sexual relationship. Issues of consent regarding sexual relationships are complex, vary by state, and typically depend on accurate data regarding the gender and age of the individuals involved in the relationship. For example, in California, the most populous state in the country, the issue of "old enough" to give consent in such a relationship is different than the legal age of adulthood.

Many states define "statutory rape" if a person is over a certain age to give consent, but is under the age of marriage. In California, if a person engages in sex with anyone under the age of 14, they will be charged with child molestation. If the age of the consenting minor is above 14 but less than 18, the adult is charged with unlawful sexual intercourse with a minor. Laws related to sexual behavior are considerably different than other state statutes regarding the behavior of minors. For example, each of the states do not allow smoking, drinking and gambling for under age minors, and most importantly, there are well established methods of verifying age in order to prevent under age minors from engaging in these activities. Social networking websites like MySpace.com do not employ any methods of age verification. The focus of the paper is to examine the legal and ethical issues involved in social networking through Internet communities. Further, a consideration of web-based relationships involving minors and issues of consent are addressed in the paper.

Consent, Cybersex, Child Molestation

I24 A Critical Review of the False Confessions Literature

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The goal of this presentation is to feature a critical review of the literature regarding false confessions. The presentation will address four questions. These questions are: How often do false confessions occur; what are the types of false confession; what interrogation tactics are believed to produce false confessions; and how can false confessions be identified? Answering these questions will help attendees gain a better understanding of the false confession phenomena and what can be done about it.

This presentation will impact the forensic community and/or humanity by presenting a critical review of the literature, the forensic community will have a greater understanding of both the phenomena of false confessions and what the limitations of knowledge are.

Identifying how often false confessions occur is difficult. Some of the reasons for this are the difficulty in establishing the actual guilt or innocence of suspects in criminal cases due to a lack of direct evidence, and a lack of knowledge about how many interrogations are conducted each year. Additionally, most estimates of the occurrence of false confessions utilize cases of wrongful convictions to produce estimates of the rate of false confessions. This adds the difficulties of estimating how often wrongful convictions occur and what proportion of wrongful convictions are caused, at least in part, by false confessions. Those who have attempted to estimate the occurrence of false confessions that led to wrongful convictions have arrived at estimates that suggest that false confessions are rare, occurring in less than .04% of all FBI index crime convictions. It should also be noted that some laboratory studies have produced false confessions at rates of up to 100% under certain conditions.

Three types of false confessions are generally recognized. These are voluntary, internalized, and compliant false confessions. Voluntary false confessions occur when a person confesses to a crime without being interrogated by the police. Several possible causes for this type of false confession have been suggested. Among these are a desire for notoriety, a need to relieve guilt generated by other transgressions, an inability to distinguish fantasy from reality, a desire to protect the guilty party, and a desire for revenge. Internalized false confessions occur when a suspect is interrogated in such a way that he or she comes to believe that they may have actually committed a crime when he or she did not in fact. A three-step process is believed to produce internalized false confessions. In the first step, the suspect's confidence in his or her memory is attacked. During the second step, the interrogator suggests a reason why the suspect may not remember committing the crime in question, and in the final step, the interrogator works with the suspect to produce a narrative of the crime. Compliant false confessions occur when a suspect confesses to a crime due to interrogation but does not believe that he or she actually committed the crime. A two step model has been proposed to explain this phenomenon. During the first step, the interrogator convinces the suspect that the situation is hopeless and that the suspect will be sanctioned for committing the crime. In the second step, the interrogator gives the suspect inducements that are designed to convince the suspect that the benefits of confession outweigh the costs of not confessing.

The tactics that are believed to produce false confessions can be divided into two categories. The first consists of tactics that have been identified by the courts as violating the voluntariness standard for the admission of a confession. These tactics include explicit threats of punishment or promises of leniency, physical abuse, interrogations that are extremely long in duration, and the deprivation of sleep or food. The

second category consists of those tactics that false confession researchers believe cause false confessions. Chief among these are the use of false evidence and attempts to minimize the perceived seriousness of an offence. While a few experiments have suggested that these tactics may produce false confessions, these experiments have generally not been replicated, and the few replications that have been done have produced inconsistent results. Additionally, the results of these experiments have often been inappropriately generalized between the types of false confessions. To add to these limitations, research into actual cases of false confessions that produced wrongful convictions suggests that is the tactics that have been identified by courts and not those that have been identified by researchers that, in and of themselves, produce false confessions under field conditions.

There is general agreement about how false confessions can be identified. Interrogations should be recorded, and confessions should be corroborated by comparing them to the facts of the case. Recording is necessary because it allows the interrogation to be reviewed to ensure that the facts of the case were not (accidentally or intentionally) leaked to the suspect during the interrogation process. Research has also generally indicated that recording does not reduce the rate at which suspects confess or how often an interrogation is admitted into evidence in court proceedings.

False Confessions, Interviewing, Interrogation

I25 Familicide in the Elderly: Mercy or Murder?

Scott A. Bresler, PhD, and Julia A. King*, University of Cincinnati Division of Forensic Psychiatry, 231 Albert Sabin Way, PO Box 670559, Cincinnati, OH 45267-0559*

After attending this presentation, attendees will understand specific issues relevant to familicide, what issues should be assessed in familicide perpetrated by elderly caregivers, and what to expect as an expert witness assessing trial competency and criminal responsibility in these types of cases.

This presentation will impact the forensic community and/or humanity by addressing an emerging and important topic often neglected in forensic mental health assessment. There are important ethical and jurisprudence considerations in these types of cases. Little has been written on this topic. This presentation will be informative and stimulating for all those attending.

A 76-year-old man with no criminal history wakes one morning and kills his wife with whom he has lived amiably for over 45 years. He loads a pistol and shoots her in the head at point blank range while she rested in her bed. He then proceeds to an adjoining bedroom and kills his elderly sister who has resided with the couple for some time. The elderly man unloads the pistol, places it carefully on the kitchen table, and calls his daughter on the phone, informing her of the things he has done "for the good of all" involved. When the police arrive at the scene of the killings, they find the suspect who candidly admits that he pulled the trigger, killed his wife and sister, and felt totally justified in doing so. He would later tell police in detail how his wife suffered from medical ailments that caused her pain and discomfort. He also elaborated on his sister who had progressively deteriorated over the years and was diagnosed as suffering from dementia of the Alzheimer's type. The elderly male suspect was arrested and booked on charges of two counts first-degree murder, in this case, constituting a capital offense in a death penalty state.

The presentation will provide up-to-date findings about the phenomenon of "mercy killings" in the elderly, a topic receiving greater attention in the media and apparently, not as rare as one would expect. Specific attention will be focused on factors such as depression, dementia, late onset post-traumatic stress disorder, and life-long

substance abuse. In the case example described above, the specific issues of trial competency and criminal responsibility emerged. These findings will be presented in detail. In addition, neuropsychological testing and a neuropathology report of the defendant (he died in jail custody) will be presented and discussed. Finally, issues relevant to jurisprudence in these types of cases will be reviewed. In particular, specific issues relevant to the prosecution of such cases (e.g., the reluctance of prosecutors to bring these cases to trial) will be reported. Ethical issues will be discussed such as pressure on evaluators to find elderly defendants Not Guilty by Reason of Insanity so that the case can be quietly disposed of by agreement between defense counsel and prosecution.

With an aging population across the United States, trends are emerging that reveal people living longer with various levels of infirmity while decreased resources to care for these elderly persons are strained beyond their limits. The burden of caregiving for the elderly is a well-understood and documented reality. As the population continues to age, the authors contend that there will be an increased number of familicide carried out by overly stressed primary care givers in the home. Many of these caregivers will be elderly spouses, significant others, and siblings who have their own health issues to manage. Under such stress, deterioration in mental health due to normal cognitive decline, as well as depression and dementia will emerge. Understanding the complexities of these types of cases and preparing to assist the courts as expert evaluators in these types of cases is an important focus for the forensic evaluator.

Familicide, Dementia, Caregiver Burden

I26 Psychological Reconstruction of Suicide in the Young

William Cardasis, MD, 202 East Washington Street, Suite 208, Ann Arbor, MI 48104-2017*

After attending this presentation, attendees will understand how the implementation of a model protocol for the evaluation and psychological reconstruction of completed suicides in children and adolescents will assist getting evidence-based prevention interventions into practice.

This presentation will impact the forensic community and/or humanity by providing information about potential risk factors for suicide in children, adolescents, and young adults.

Almost all cultures intuitively recognize suicide in the young as a threat to social cohesiveness. Society has an emotional investment in its children and a sense of responsibility to ensure their well being. When youth suicides occur, there is an overwhelming desire to determine what caused the event and how it could have been prevented. Suicide is a function of a number of factors: socioeconomic, intrapersonal, and interpersonal stress, cultural mores, social forces, and physical and mental health (Cavanagh, J.T., Carson, A.J., et al., *Psychological Autopsy Studies of Suicide*, 2003).

The specific aims of the project are to: 1) work collaboratively with health professionals, the medical examiner's office, law enforcement, and other professional agencies involved in the investigation of suicide cases, and to identify the causes of suicide; 2) determine the degree to which substance abuse was a factor in relationship to other possible causative factors; 3) identify most effective bereavement assistance practices for survivors; 4) select effective suicide intervention/prevention training model for mental health professionals, physicians, nurses, clergy, school counselors, teachers and others who work with children to increase sensitivity and receptivity to suicidal messages and concerning behavior; 5) clarify the role of friends, family, peers, classmates, and others in early recognition and prevention of suicidal behavior; 6) increase widespread understanding of suicide interventions by working with community prevention coalitions to impart research findings at the grassroots level.

In summary, the findings derived from the project will be shared with professionals in public health, education, law, medicine, criminal justice, psychology, and other behavioral sciences in an effort to provide a more complete understanding of factors that contribute to youth suicide.

Suicide, Youth, Psychological Reconstruction

I27 Autistic Spectrum Disorders: Forensic and Educational Implications

Gagan Dhaliwal, MD, 608 Davis Circle, SW, Huntsville, AL 35801*

After attending this presentation, attendees will understand how to Define IDEA, FAPE, and additional legislation regarding special education needs; the role of a child and forensic psychiatrist in performing diagnostic, developmental, and educational needs assessment; and review the administrative due process hearing, appeals process, and evidentiary standards, and ethical differences between an attorney and an expert in special education disputes.

This presentation will impact the forensic community and/or humanity by enhancing knowledge about IDEA, FAPE, and role of a child and forensic psychiatrist in performing diagnostic, developmental, and educational needs assessment in autism.

Autism is one of the most widely recognized and reliably diagnosed developmental disorders and its prevalence and diagnosis has increased in recent years.

The paper will define Individuals with Disabilities Education Act; Free and Appropriate Public Education (FAPE) and its application to Autistic spectrum illnesses. It will include case law regarding school based litigation and definitions of terms, "meaningful benefit," "reasonable choice," and "least restrictive environment (LRE)."

Using case vignettes, psychiatric and educational assessment of children with autism will be addressed. Use of multi-domain assessment tools in autism and preparation of report and testimony for an administrative hearing will be discussed. Finally, various educational interventions in autism including Applied Behavior Analysis (ABA) and TEACH will be addressed along with differences in ethical goals between an expert and an attorney involved in autism related school litigation.

IDEA, Free Appropriate Education, Least Restrictive Environment

I28 The Psycho-Legal Implications of Brain Trauma: A Case of Episodic Dyscontrol and Central Brain Tumor

Adam M. Weisman, PhD, USC Institute of Psychiatry, Law and Behavioral Science, PO Box 29366, Los Angeles, CA 90029-0366; and Joseph R. Simpson, MD, PhD, Veterans Administration Medical Center-Long Beach, PO Box 15597, Long Beach, CA 90815*

After attending this presentation, attendees will be exposed to an actual case of episodic dyscontrol that is linked to central brain tumor neurosurgery. The case example will include neuroimaging results and social history information. The impact of the forensic examination on legal disposition will be outlined to give attendees insight into how the neurological condition can be used in mitigation.

This presentation will impact the forensic community and/or humanity by increasing understanding of the interaction of neurological conditions and human physical aggression. The community will gain insight as to how to conceptualize such criminal cases & legal strategies towards effective dispositions.

Upon completing this lecture, the participant will be able to understand the phenomenon of episodic dyscontrol linked to central brain tumor. With a criminal case featuring neuroimaging data and social history information, attendees may develop forensic strategies to assist the court system in mitigation and effective legal dispositions.

The presentation will influence the forensic community by demonstrating one result of an undisclosed central brain tumor and human physical aggression. The community will gain insight as to how a person's neurological condition may be used as mitigation at a criminal trial.

Forensic examiners are often presented with criminal cases involving domestic violence or episodic dyscontrol. In such cases, the defendant's personality constitutional (static) and situational (dynamic) factors are often assessed in opining causality, dangerousness risk and dispositional recommendations. When a defendant presents with an overt neurological condition, such as trauma or stroke, examiners and the court are often drawn to the unconcealed brain damage in explaining away the criminal act. However, in the case of central brain tumors, the defendant often appears normal apart from nonspecific somatic complaints such as headaches, nausea, or dizziness. Such nonspecific symptoms pose a problem in attempting to explain the defendant's alleged violent criminality.

This presentation will provide an example of a central brain tumor and its link to criminally violent behavior. The case involves a 21-year-old female charged with two counts of assault with a knife and vehicle. The defendant had dated the victim for 3 years and ended a few weeks before the instant offense. On 10/26/05, the defendant got into an argument with the victim and the victim's new girlfriend. In the midst of the argument, the defendant became enraged, pulled out a kitchen steak knife, and assaulted the victim. The victim fled in his vehicle, followed by the defendant in her vehicle. Within a few blocks, the defendant struck the victim's vehicle. The defendant had no history of criminality and was released on own recognizance with an electronic monitor.

The forensic examination revealed a family history of property crimes, cocaine use, and a sister with bipolar illness. She completed high school and worked recently as a data entry clerk. There was no history of mental health treatment or illicit substance use. Alcohol use was restricted to rare social events. In the year prior to the instant offense, the defendant began experiencing physical symptoms, including chronic headaches, lactation during intercourse, abnormal menstrual periods, nausea, and vomiting. She was eventually diagnosed with a tumor located in her pituitary gland. On 9/23/05, the tumor was reduced through nasal surgery, approximately 30 days before the instant offense.

In the forensic evaluation report, the defendant was diagnosed with an adjustment disorder with a disturbance of conduct. Prior to the evaluation, the strategy of defense counsel was to present the case as a domestic conflict leading to aggressive behavior. The defendant was angry simply because the victim had a new girlfriend. However, the neurological condition provides a different conceptual framework. Because the central brain region is linked to emotions and social control, the recent neurosurgery may have left the defendant vulnerable to episodic dyscontrol. Additionally, any dispositional recommendations would have to acknowledge the role of the treating endocrinologist, neurologist, and mental health clinician.

As a part of this presentation, a combination of clinical data and neurological imaging data will be presented to understand better the nature of the defendant's brain trauma. Records from treating physicians and neurosurgeons will highlight the link between the tumor and behavioral dyscontrol.

Violence, Brain Trauma, Forensic Evaluation



J1 The Application of Photomontage Software to Physical Document Examinations

Gregg Mokrzycki, MFS, and Gabe D. Watts, BA, FBI Laboratory, 2501 Investigation Parkway, Quantico, VA 22135*

After attending this presentation, attendees will understand how to merge several partially focused images into one clear image.

This presentation will impact the forensic community and/or humanity by demonstrating how examiners can combine several partially focused images into one clear image that can possibly be used in court charts, presentations, or case notes.

Photomontage® software combines several partially focused photographs into one completely focused image. This poster will display the application of a photomontage system to various forensic document examinations. “Before and after” images of cut/fractured edge comparisons, typewriter examinations, and rubber stamp examinations will show differences between a conventional image capture system and one produced utilizing photomontage software. The advantages and disadvantages of this software, as well as alternative options will be covered.

Photo Montage®, Physical Document Examinations, Image Processing

J2 Ballpoint Pen Defect

Jane A. Lewis, MFS, Wisconsin State Crime Lab-Milwaukee, 1578 South 11th Street, Milwaukee, WI 53204*

After attending this presentation, attendees will understand how manufacturing defects in ballpoint pens do exist; however, the incidence of these defects may be small. Applications may include the recognition of the cause of blobbing characteristics of an ink line and their association with a particular pen.

This presentation will impact the forensic community and/or humanity by assisting attendees to recognize this defect may be useful in associating ballpoint pen writing with a particular pen. This observation may also help to determine whether a document is altered based on defects in the ink lines.

A new ballpoint pen produced an unusual writing defect. The defect originated from malformed ball housing. Photographs illustrate the defect on the pen ball housing and samples of the repetitive defect on a handwriting sample. In the past it was assumed that defects were usually caused by dirt or debris on the ball housing. This case is an example of a manufacturing defect of the ballpoint pen housing.

Forensic document examiners (FDEs) observe the morphology of an ink line and use it as an element of consideration in the comparison between questioned and known writings. FDEs need to understand the origin and significance of anomalies in the ink line on paper. FDEs like Brunelle (2003) have described the phenomenon of defects like gooping and striations. A ballpoint pen includes the point assembly which consists of the ball housing and the ball as defined by Brunelle (1984). This assembly deposits viscose ink on paper. Deviations of the shape of the ball housing may produce ballpoint pen defects that can be observed in the ink line on paper. Observations of defects in an ink line have been discussed by Hueng and Leung (1985) and Lewis (2003). This paper illustrates the origin of a particular ballpoint pen defect in a new pen.

Ballpoint Pen, Defect, Questioned Document

J3 An Image Processing Method Purported to be Useful in the Detection of Image Manipulation

Arthur T. Anthony, BS, Georgia Bureau of Investigation, Division of Forensic Sciences, PO Box 370808, 3121 Panthersville Road, Decatur, GA 30037-0808*

After attending this presentation, attendees will understand a technique purported to detect manipulation of digital images.

This presentation will impact the forensic community and/or humanity by providing awareness of a method potentially useful in the detection of fraudulent manipulated digital images.

While researching a *Daubert* decision on the web an article surfaced discussing the disgraced South Korean stem cell researcher accused of a hoax in connection with a cloning project. A link ultimately led to an intriguing *New York Times* article concerning “photo-manipulation.” This paper will explore simple techniques found to be of value in detecting image manipulation by the editors of *The Journal of Cell Biology*. The editors of this web based journal discovered that 25 percent of all manuscripts accepted for publication contained one or more illustration images had been manipulated. It was reported that most cases were resolved upon analysis of original images, however, one percent of the authors were “engaged in fraud.” This paper will report on the evaluation of these simple techniques used to test electronic image integrity. It appears that the editors of *The Journal of Cell Biology* may have sparked a controversy in the scientific journal arena. According to the *Times* article the journal *Science* has incorporated *The Journal of Cell Biology's* techniques and guidelines for authors concerning digital images. It was reported that the editor of the journal *Cell* is of the belief that it is an ethical matter for the submitting scientist and not the place for editors to police their data. This paper will explore the possibility of using the techniques described by the Executive Editor of *The Journal of Cell Biology* to determine image manipulation for only electronic images but images printed from electronic images.

Questioned Documents, Digital Image Manipulation, Image Processing

J4 Digital Technology: Friend or Foe?

Kelley C. Harris, MFS, and Kerre L. Corbin, BS, United States Secret Service, Criminal Investigative Division, 950 H Street NW, Washington, DC 20223*

After attending this presentation, attendees will understand the importance of counterfeit detection, the difference between traditional and digital counterfeiting, and how the printing processes used by counterfeiters have evolved over the past decade. The author will also discuss the lengths some counterfeiters will go to in an attempt to deceive the public.

This presentation will impact the forensic community and/or humanity by providing a thorough discussion of how techniques used to counterfeit United States currency have evolved as technology has advanced and become more affordable to attain.

This presentation will provide a thorough discussion of how techniques used to counterfeit United States currency have evolved as technology has advanced and become more affordable to attain. The author will present examples and statistics of the most common and abundant types of counterfeits to demonstrate this effect.

The act of counterfeiting has existed as long as people have used metals and other valuables to hold and exchange wealth. Every year the public is victimized by the counterfeiting of U.S. currency, and counterfeiting has always kept pace with the latest technology. As a result, there is a continuing challenge to stay “one step ahead” of the counterfeiter. This has resulted in a strategy of regularly enhancing the design of U.S. currency and incorporating more advanced security features to maintain the security and confidence in the U.S. Dollar.

Prior to the advancement of computer technologies such as the inkjet and laser printer, counterfeiters had to utilize traditional printing processes to produce their counterfeits such as an offset printing press or a hand operated intaglio press. These processes require a significant investment in equipment as well as a certain level of training and skill for proper use. Therefore these counterfeiters usually possess some sort of professional training or experience. Since producing counterfeit by one of these traditional processes generally yields a high volume of product, the printer is often required to work in conjunction with a distribution network.

Due to the technological advancement of digital printers, copiers and scanners, their widespread availability and relative low cost, the use of these devices for producing counterfeit currency has dramatically increased. Today, sophisticated copiers, printers, digital scanners, and computer software can interface with each other to present significant threats to currency. The problem with this type of counterfeiting is the vast numbers of individuals with access to this technology. Unlike traditional printing processes that require a skill or expertise, computer technology has placed the most modern printing tools in the hands of the even the most unskilled counterfeiter who can now quickly produce a passable counterfeit using equipment easily accessible through copy centers, offices and home use. While these processes require little investment or skill, they have historically produced counterfeit notes of poor quality, however as the quality of the technology has increased, so has the quality of the counterfeit notes. The creativity of the counterfeiter to improve their product has succeeded in making these counterfeits more difficult to detect.

Counterfeit, Digital Technology, Currency

J5 The Collection of Handwriting From Dry-Erase Boards

Michele C. Zeiders, BS, Pennsylvania State Police, 1800 Elmerton Avenue, Harrisburg, PA 17110*

After attending this presentation, attendees will understand how original dry-erase marker writing can be quickly and conveniently collected from some non-porous surfaces enabling examination of the original writing.

This presentation will impact the forensic community and/or humanity by enabling questioned documents examiners to examine an original questioned writing, rather than a representation thereof.

The examination of questioned text written with a dry-erase marker on a substrate other than paper was researched for improved ways of collecting and submitting this type of evidence to the Forensic Documents Examiner. When conducting a handwriting examination, the value of original writing cannot be overstated. However, in cases of this type, the collection of original questioned writing by traditional methods may be difficult or impractical. Typically, the questioned writing is documented photographically or the entire writing substrate is collected and submitted en masse. Both methods have disadvantages. It was noted that original dry-erase marker writing can be quickly and conveniently collected from some non-porous surfaces enabling examination of the original writing, rather than a representation thereof.

Questioned Text, Dry-Erase Markers, Collection of Evidence

J6 What's In Your Basement? A Counterfeiter's Workshop

Kerre L. Corbin, BS, and Kelley C. Harris, MFS, United States Secret Service, Criminal Investigative Division, 950 H Street NW, Washington, DC 20223*

After attending this presentation, attendees will be introduced to the variety of items found at a counterfeit crime scene and understand how common household items may be used to produce counterfeit banknotes. Attendees will be given a brief overview of one of the many processes used to associate counterfeit banknotes to a genuine pattern banknote in addition to other counterfeit banknotes.

This presentation will impact the forensic community and/or humanity by providing a thorough discussion of a typical counterfeit crime scene and the forensic evidence that should be collected for examination. The author will use an actual case to demonstrate the method of association by defects to a common source.

A counterfeit crime scene could be located almost anywhere; hotel room, car, basement, or bathroom. The counterfeiter may use chemicals, art supplies, computers, printers, and home-made “machines” to accomplish the task. The counterfeit crime scene is highly dependant on the innovative ideas and resourcefulness of the counterfeiter, so a simple machine may be obtained and modified slightly or designed from its inception to meet the needs of the counterfeiter. Many household items may be used by a counterfeiter to simulate the security features on a genuine banknote; such as a glitter pen to simulate the color shifting ink. All these items must be considered when collecting and examining the evidence at a crime scene.

The most widely used method for identifying US currency is the simple act of touching and handling the note because the banknote has a distinctive feel to it. This has encouraged many counterfeiters to “bleach” low denomination genuine banknotes and print higher denomination images on the genuine paper. The process of bleaching involves chemicals that remove the ink from the banknote as well as retaining the red and blue security fibers. The case presented will demonstrate how the counterfeiter designed and built an electronic “bleaching” machine to remove the ink from genuine \$1 banknotes then printed \$50 and \$100 counterfeit banknotes with an inkjet printer.

The use of digital technologies for producing counterfeit has risen due to their universal accessibility, low cost and ease of use. Computers, printers, copiers, and scanners assist the criminal without the large expense of an offset printing press. The author will discuss the concept of reproducible defects and how it relates to the technologies used by today's counterfeiters. Due to the distinctive nature of the genuine printing process, comparisons between counterfeit banknotes can be achieved and in turn counterfeit banknotes can be associated to a particular source. The case presented will demonstrate how the original genuine banknote can be linked to a computer image, the computer image linked to a printout of that image and finally the printout linked to a counterfeit banknote. The ability to prove that a counterfeit banknote was produced from a particular image is an effective way to link multiple counterfeit banknotes to a single source; thereby increasing the monetary responsibility of the counterfeiter once apprehended.

Crime Scene, Counterfeit, Currency

J7 “Watch That Step!” A Traumatic Injury Results in the Need for a Right-Handed Writer to Learn How to Write With the Left Hand

Carolyn M. Bayer-Broring, MFS, Immigration and Customs Enforcement, Forensic Document Laboratory, 8000 Westpark Drive, Suite 200, McLean, VA 22102-3105*

The goal of this presentation is to document a case study of an individual forced by injury to learn how to write “wrong-handed” (using the unaccustomed, in this case left, hand) and to demonstrate to attendees the process of an adult re-learning how to write.

This presentation will impact the forensic community and/or humanity by illustrating the ability of an adult writer to learn how to write “wrong-handed” and then to re-learn how to write with the dominant hand. Future studies on traumatic injury and its effects on the ability to write with the dominant hand may provide additional insight into similar cases.

On December 15, 2005, a fifty-year old female fell down a flight of stairs and suffered a traumatic compression injury of her right wrist. On December 16 the woman underwent surgery to install a “T”-plate and screws in the wrist and to install an external fixating device to stabilize the wrist.

Prior to sustaining the injury, the woman’s dominant writing hand was exclusively the right hand. In her cursive writing she displayed a measured, classic copybook style of writing based on the Palmer method that she recalls learning in second-grade while attending elementary school in Fairfax County, Virginia in the 1950’s. She observed that her mother has “beautiful” cursive writing and that she writes exclusively right-handed. Her father (deceased) was left-handed with “beautiful” cursive writing that was very vertical in its appearance. She has two siblings, both of whom are right-handed.

Due to the injury, the presence of the external fixating device and the need for total rest of the damaged hand, the woman was forced to write exclusively with the left hand for a period of time. The night of the injury was the first occasion writing with the left hand, having been forced to sign her name with the left hand while still in the emergency room of the hospital. Prior to sustaining the injury, she never consciously tried to write with the left hand, aside from the occasional childhood attempt to try to write with the “wrong hand”. One curious observation was that she claimed to have been able to write upside down with the right hand prior to the injury. It is not known if she still has that ability.

Subsequent to the surgery, she continued out of necessity to write exclusively with the left hand for approximately 40 days. The external fixator device was removed on January 14, 2006, a splint was utilized to stabilize the wrist, and six weeks of physical therapy were prescribed. By January 30, 2006, the woman documented her first attempts at starting to use the right hand to write again, still aided by the splint and physical therapy. During this recovery time she still wrote with the left hand primarily. By February 14, 2006 the woman was predominantly using the right hand for writing, occasionally switching to the left when pain or fatigue was felt in the right. At this point, she was experiencing difficulty re-gaining lost flexibility in her thumb and pinky fingers on the right hand and was not always able to properly support a writing instrument when trying to use the right hand. She also found it difficult and painful to exert pressure with the right hand, such as that experienced when writing checks that use carbons.

Throughout the course of her recovery, the woman provided periodic handwriting samples for this study, using both the left and right hand, to document the process of learning how to use the left hand and documenting the process of perfecting the left handed, and subsequently the right handed, writing. When asked about the current ability to use the right hand versus the left, she states that she is mostly right handed but still can use the left and does so more often than before sustaining the injury. She states that she uses the left hand when it makes it “easier”

to do so. She has observed that she now has the ability to use the right hand to scan a document such as a chart or spreadsheet while using the left to write notes, and that this ability is not something she remembers having prior to sustaining the injury.

Compression Injury, External Fixating Device, Dominant Writing Hand

J8 The Analysis of 2-Phenoxyethanol for the Dating of Documents

Gerald M. LaPorte, MSFS, David Stoker, BS, Yvette Thomas, MFS, Joseph Stephens, MSFS, and Douglas K. Shaffer, MS, United States Secret Service, Forensic Services Division, 950 H Street NW, Washington, DC 20223*

After attending this presentation, attendees will understand more about the principles of 2- phenoxyethanol (PE) a common volatile organic compound found in many ballpoint writing inks. It is a generally accepted principle that the level of PE diminishes as an ink evaporates and therefore may be used in some circumstances to ascertain if an ink entry(ies) was produced on the purported date(s) of a document.

This presentation will impact the forensic community and/or humanity by providing some fundamental information about PE levels found in fresh ink samples from various types of pens, and how the levels of PE evaporate under controlled conditions. Understanding the dynamics of PE can help forensic examiners form conclusions based on the levels of PE in certain cases.

Reliably determining the age of an ink on paper continues to be a significant challenge for forensic document examiners. There are generally accepted static methods that may be used to help ascertain if written entries were produced on their purported date. Manufacturers may add chemical tags to identify the year the ink was first used, the presence of certain ingredients introduced into a formulation on a known date may be identified, and/or a questioned ink can be compared with a known database of standards to ascertain when a formulation was first commercially available. Reliably measuring a component of ink that is known to change as ink ages such as PE, is more challenging, and requires considerable understanding with regards to external factors that may affect interpretations. Therefore, the objective of this study was to perform a series of experiments on various brands of black ballpoint inks to determine: i) the initial levels of PE in a fresh sample of ink with a range of variation; ii) how the levels of PE changed as the inks aged and; iii) how the inks aged on different substrates.

This research presents the preliminary results from these studies and discusses the practical aspects of utilizing this information to conduct ink dating examinations on a case-by-case basis. There should be certain criteria established when using and interpreting PE levels to form conclusions.

Ink Dating, Phenoxyethanol, Ink Aging

J9 Analysis of Writing Ink by Gas Chromatography-Mass Spectrometry: Batch Variations

Albert H. Lyter, PhD, Federal Forensic Associates, PO Box 31567, Raleigh, NC 27622*

After attending this presentation, attendees will understand the differentiation capability of GC/MS in the examination of handwritten entries and its pitfalls.

This presentation will impact the forensic community and/or humanity by providing a further refinement of methodology for the differentiation of writing ink samples, including limitations and pitfalls.

Attendees will assess the ability to differentiate batch variations among handwritten writing ink entries using GC/MS, as compared with other analytical methodologies.

Since writing ink is a manufactured product, it is susceptible to quality control issues. Numerous writings have been published using both physical and chemical methodologies to differentiate both ink formulations and different batches of the same formulation. Gas Chromatography-Mass Spectrometry is recognized as a technique with a high discriminating power and thus should be appropriate for this purpose.

Several different ink formulations were identified and chosen for analysis based upon their apparent similarity of components. These samples were both blue and black ball pen and contained numerous samples of different manufacturing batches. All of the samples examined were prepared at least 2 years before the date of examination. Each sample was examined by infrared reflectance and luminescence, thin layer chromatography, TLC densitometry and GC/MS. Triplicate analysis of each writing sample was performed and statistical analysis of the data was conducted.

The applicability of GC/MS to the examination of writing inks is evident, due to its ability to detect components that are not normally detectable by the other reported methodologies. However, depending upon the particular ink formulation examined, results obtained from samples of different batches of the same formulation were of a magnitude consistent with variations normally found between different ink formulations.

Ink Analysis, Questioned Documents, Batch Variation

J10 Discrimination of Document Paper by Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS)

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After attending this presentation, attendees will have gained an appreciation of the strong potential of LA ICPMS for forensic paper investigations.

This presentation will impact the forensic community and/or humanity by demonstrating how LA ICPMS is a very discriminating technique for forensic paper investigations and therefore can provide important forensic evidence especially in cases involving anonymous letters, the counterfeit manufacture of paper banknotes, and document fraud. The technique is used for forensic investigations into threat letters and terrorism related incidents.

The discrimination between sheets of document paper can provide important forensic evidence, especially in cases involving anonymous letters, the counterfeit manufacture of paper banknotes and document fraud. Historically paper characterization has relied upon the measurement of gross physical properties such as strength, thickness, mass per unit area or the measurement of fiber content, color, and fluorescence. However, the problem with using these methods for the characterization of paper remains the inability to match two sheets of paper with a high degree of certainty.

In this work a detailed evaluation of Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS) for discriminating document paper is presented. Using LA-ICP-MS an elemental profile can be measured of both major and trace elements present in the paper. It will be shown that these elemental profiles are highly characteristic for the origin of the paper.

Inductively coupled plasma mass spectrometry (ICP-MS) has been applied to many types of material that are commonly encountered in forensic investigations, such as plastics, tape, bullet alloys, and glass but until relatively recently it had not been applied to paper. Spence and others¹ have employed solution nebulization ICP-MS for the characterization of document paper. The discrimination of papers from different sources was attempted by virtue of their elemental compositions. Nine elements were found to be suitable discriminators because of their high concentrations. The results showed that elemental analysis using ICP-MS provides an effective and robust technique for the discrimination of document paper. In this study the authors will focus on the possibilities of LA-ICP-MS. Compared to solution nebulization ICP-MS it offers several advantages such as speed and a smaller required sample size. In the same analysis also printed ink can be analyzed.

The discriminating power of LA-ICP-MS was evaluated by analyzing 25 different paper types from the European market. From two paper types also several paper batches were measured. A small piece of paper was cut out from the sheet and put into the ablation chamber. The paper is subsequently ablated using a 213 nm Nd:YAG laser with a spot size of 140 µm and a line-scan of 5000 µm. The ablated material is swept into an Elan 6100 ICP-MS which uses an element program of 45 elements. The time dependent signal from the line scan is integrated. In the comparisons of document papers net element intensities are used that are normalized relative to the intensity of strontium. Multivariate statistical techniques such as cluster analysis, principal component analysis (PCA) and discriminant analysis (DA) were used to establish the discriminating power.

LA-ICP-MS provides full discrimination of at least 23 out of the 25 paper types. Several casework examples (document paper, banknotes, envelopes) will be discussed to demonstrate the value of LA-ICP-MS in forensic paper analysis.

¹ Spence L.D., Baker A.T. and Byrne J.P., *J. Anal. At. Spectrom.*, 2000, 15, 813-819.

ICPMS, Document, Paper

J11 Discrimination of Paper Document by Inorganic and Isotope Analysis

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After attending this presentation, attendees will have an appreciation of the strong potential of modern analytical technique combinations for forensic paper investigation.

This presentation will impact the forensic community and/or humanity by demonstrating the strong discriminating power of modern technique combinations for forensic paper investigations and in this way can provide important forensic evidence, especially in cases involving anonymous letters, the counterfeit manufacture of paper banknotes and document fraud.

The ability to discriminate between sheets of paper and to determine the origin of pages of paper can provide important forensic evidence, especially in cases involving anonymous letters, the counterfeit manufacture of paper banknotes and document fraud. This field becomes more and more important because of the increase in threatening letters addressed to public figures such as politicians and the relation to terrorist activities. One of the possibilities in these investigations is the chemical or physical analysis of the paper. This may serve to establish a relation between different anonymous letters or

to compare with paper that has been seized at a suspect's residence. There are many analytical techniques that can be used for a chemical or physical analysis of paper. However, the question is which methods or combination of methods has the highest discriminating power and which method combinations should be used.

The goal is to assess the discrimination powers of the different techniques whilst also searching for combinations of largely complementary methods so that a fast, efficient, sensitive, and reproducible analytical protocol can be established for the forensic identification and comparison of paper samples.

In this work the potential of a selection of inorganic analysis techniques is evaluated. Later it will also be combined with organic and physical characterization results of the paper. The following techniques were applied: LA-ICP-MS (Laser Ablation Inductively Coupled Mass Spectrometry), XRF (X-ray Fluorescence), XRD (X-ray Diffraction), and IRMS (Isotope Ratio Mass Spectrometry). With these techniques both major as well as trace elements present in the paper can be analyzed. A set of 25 different paper types from the European market was used for the comparisons. From two paper types also several paper batches were measured.

Multivariate statistical techniques such as cluster analysis, principal component analysis (PCA) and discriminant analysis (DA) were used to establish the discriminating power of each technique as well as combinations of techniques.

LA-ICP-MS provides the highest single discriminating power. At least 23 out of the total of 25 paper types could be fully discriminated using only this technique. In addition LA-ICP-MS is also a fast and robust technique with easy sample preparation.

Despite its lower sensitivity XRF also showed good discriminating power but the correlation with LA-ICP-MS is high and a larger sample area is necessary. XRF has added value though, especially for S, Cl and Br. Using the XRF and LA-ICP-MS combination all 25 papers can be discriminated. Interesting is that in this combination S, Cl, and Br as determined using XRF provide the highest contribution to discrimination of the technique combination.

The combination of LA-ICP-MS and IRMS provides another powerful, complementary, and strongly discriminating set of techniques, easily discriminating all 25 papers. In this combination H and C isotope ratios as determined using IRMS provide the highest contribution to discrimination of the technique combination.

Apart from the 25 paper types, samples from four UPM-Kymmene production batches were analyzed. All four batches could be discriminated using e.g., the combination of LA-ICP-MS and XRF.

The value of inorganic analysis for document paper discrimination will be further illustrated with several casework examples.

Elements, Isotopes, Paper

J12 Examination of Typographic Documents and Effective PowerPoint Courtroom Presentations

William J. Flynn, BS, Affiliated Forensic Laboratory, Inc., 7260 East Eagle Crest Drive, #33, Mesa, AZ 85207-7145*

After attending this presentation, attendees will learn how to make their own sets of typographic line spacing grids utilizing commonly available software and transparency sheets. These line spacing grids will be used along with other typographic measuring devices to determine if computer generated documents have been manipulated in one or more ways.

This presentation will impact the forensic community and/or humanity by demonstrating how forgeries and document manipulation by means of computer technology have become a common type case seen in forensic document laboratories. This presentation will discuss

how computer manipulations can be detected and a second part of the presentation will deal with the presentation of these findings in court.

The focus of the workshop is the forensic examination of typographically prepared documents. Topics covered will include a brief history of typography, typographic measurements, font differentiation, "typical," (default) lifespans, and how to calculate line spacing rules. Also covered are: font "efficiency," kerning, "weight," style, and how these and other factors affect the number of typographic characters that fit in a given line length.

Attendees will learn how to make their own sets of typographic line spacing grids utilizing commonly available software and transparency sheets. These line spacing grids will be used along with other typographic measuring devices to determine if computer generated documents have been manipulated in one or more ways.

All of those attending are asked to bring "MicroRef" Pro-Designer Rulers #1 and 2a prior to the meeting in order to make the necessary measurements for this session.

The second part of the program will be a discussion and demonstration of PowerPoint techniques that can be used to create interactive courtroom presentations. This will cover everything from color and font choices to little used animation techniques that are built into PowerPoint.

Typography, Document Fraud, Computer

J13 Classification of Counterfeit Japanese Passports Using the Quantification Theory Type 3

Yoko Seki, MA, Shigeru Sugawara, MS, and Toshiyasu Koyama, BA, National Research Institute of Police Science, 6-3-1, Kashiwanoha, Kashiwa-shi, Chiba 277-0882, Japan; and Takahiko Izuno, BA, Metropolitan Police Department, 2-1-1, Kasuigaseki, Chiyoda-ku, Tokyo 100-8929, Japan*

After attending this presentation, attendees will have information regarding thirty-seven counterfeit passports that were classified based on their printing methods using the Quantification Theory Type 3 to classify the printing methods and the passports into three groups.

This presentation will impact the forensic community and/or humanity by demonstrating the application of the statistical method, Quantification Theory Type 3, to forensic document examination thereby showing the importance of the printing method of the background as well as the examiner's knowledge of counterfeiting.

Learning Objective and Outcome: Thirty-seven counterfeit passports were classified based on their printing methods. The Quantification Theory Type 3 classified the printing methods and the passports into three groups respectively. Analysis also showed that printing methods used for the background was the basic information for the classification.

There are various methods used for counterfeiting printed materials. Counterfeiters are expected to have a counterfeiting technique of their own. Two passports which are made by the same counterfeiting technique may indicate that they are made by the same counterfeiter. If that is true, one can identify a counterfeiter by the comparison of the counterfeiting technique used. Researchers collected 37 counterfeit Japanese passports and classified them to get fundamental information on the relationship between the printing method and the counterfeiting technique.

Thirty-seven counterfeit Japanese passports were identified the printing methods by the microscopic observation. Printing methods of the portrait, signature, background, fixed letters, and personal data letters on the inside front page were examined.

The printing devices or the printing methods used for counterfeiting were as follows; inkjet printer, full-color laser printer, black toner

printer, thermal transfer printer, dye sublimation printer and lithography. An inkjet printer was the most frequently used for the forgery. Nearly eighty-five percent of the portraits were printed by the inkjet printer. A black toner printer, on the other hand, was the most frequently used for printing personal data. A dye sublimation printer was mainly used for printing the portrait and/or background. Lithography was used only for the background.

Variety of the printing methods was analyzed using the Quantification Theory Type 3. Printing methods were classified into three groups by the category score. Three groups were as follows; full color laser printer, combination of the inkjet printer and the black toner printer, and the combination of the dye sublimation printer and the lithography or thermal transfer printer. Passports were also classified into three groups by the sample score. Characteristics of each group correspond with the result of the category score. Some passports that were printed by the same printing method had the same printing defects in common.

The analysis suggests that the printing method used for the background is the key information for the classification because the dye sublimation printer and the lithography are used mainly for the background. This also suggests that there are roughly two main counterfeiting methods.

Counterfeit Passport, Printing Method, Quantification Theory Type 3

J14 A Comparison of the Physical and Chemical Characterization of Conventional Toners vs. Chemically Prepared Toners

Douglas K. Shaffer, MS, Joseph Stephens, MSFS, and Gerald LaPorte, MSFS, United States Secret Service, Forensic Services Division, 950 H Street, NW, Washington, DC 20223*

After attending this presentation, attendees will gain a better understanding of how conventional and chemically prepared toners are prepared and how they can be analyzed, from an evidential standpoint, to provide valuable forensic information.

This presentation will impact the forensic community and/or humanity by providing the forensic community with fundamental information regarding the raw materials, manufacturing processes and analytical characterization of both conventional and chemically prepared toners, which are frequently encountered in questioned document cases.

The characterization of conventional toners, prepared by melt mixing and grinding processes, has been well documented. As toner manufacturers have begun a changeover to new “chemically prepared toners,” or “CPTs,” the physical and chemical characterization of these revolutionary materials has not been reported. After attending this presentation, attendees will better understand how conventional and chemically prepared toners are prepared and how they can be analyzed, from an evidential standpoint, to provide valuable forensic information.

Commercial toners are produced for use in various office machine systems, including photocopiers and laser printers, which are frequently associated with criminal cases involving questioned documents. This presentation will provide the forensic community with fundamental information regarding the raw materials, manufacturing processes and analytical characterization of both conventional and chemically prepared toners, which are rapidly becoming the predominant product lines in the worldwide toner market.

Conventional toners have been characterized to assist in the classification of various office copy and laser printer machines. Instrumental techniques, including Fourier transfer infrared (FTIR) spectroscopy, gas chromatography-mass spectrometry (GC-MS) and

pyrolysis GC-MS (pyGC-MS) have been used to analyze the polymeric (resin) component of commercial toner formulations, while the particulate (e.g. carbon black) constituents have been examined using scanning electron microscopy (SEM), often in conjunction with energy dispersive x-ray analysis (EDXA). New chemically prepared toners, prepared by various addition and condensation polymerization processes, are affording some extraordinary performance properties. These toners have yet to be well characterized by the scientific community. As manufacturers attempt to “individualize” their products by employing a unique additive or a special particulate morphology, such properties may actually assist the forensic scientist in tracing the toner(s) to a particular manufacturing source and, potentially, to a specific office machine. The objective of this study has been to investigate the expanding gamut of new CPT products and compare them, using FTIR, SEM and other instrumental methods, both with each other and with existing conventional toners, to establish a database for use in forensic casework.

This research will present results from these studies and discuss the practical aspects of employing this information to identify and track toner products on a case-by-case basis.

Toners, Electrophotography, FTIR

J15 Validating the ImageXpert™ Full Motion System: A Foundation to Support Future Research Into Document Authentication

Jim Ross, MFS, Troy J. Eberhardt, BS*, and George Virgin, BS*, United States Immigration & Customs Enforcement, 8000 Westpark Drive, Suite 200, Mclean, VA 22102*

After attending this presentation, attendees will learn about current research being conducted by the U.S. Immigration & Customs Enforcement’s Forensic Document Laboratory (FDL) to validate the ImageXpert® Full Motion System.

This presentation will impact the forensic community and/or humanity by demonstrating how the implementation of an automated imaging system such as the ImageXpert® system will provide a means for the forensic document community to report an accurate and objective forensic finding on the authenticity of a questioned document such as a passport, visas, or banknote.

ImageXpert® Full Motion System is an automated machine-vision based image quality analyzer developed by ImageXpert, Inc. of Nashua, New Hampshire. ImageXpert® has established a reliable reputation amongst manufacturers in the digital printing industry and many companies have incorporated such vision systems into the inspection/testing phase of their products. Over the past few years, several studies have been undertaken utilizing this system to determine its effectiveness. These preliminary studies have proven to be quite promising; therefore, this study was undertaken to provide further confirmation of the accuracy and capabilities of this system and to establish whether or not the results would be precise enough to withstand the scrutiny of a court of law. The ultimate goal of this ongoing research is to determine whether or not the system can provide a more objective, quantitative means for document examiners to authentic questioned documents through the use of print quality measurements.

Although previous studies of the ImageXpert® system focused primarily on those measurements which would differentiate between genuine and counterfeit documents, this study was geared toward the validation of the system itself and; therefore, all of the measurements executable by the system were considered in this study and were tested as completely as possible. The study of all of these measurements was conducted using a NIST (National Institute of Standards) traceable calibration target to insure the accurate reporting of the error rates. The

authors will discuss the methods and procedures used during the calibration of the system and will also present many of the variables encountered during the testing. Because of the fact that vision based systems operate with the use of specialized lighting and cameras, it was extremely important to systematically calibrate the instrument while performing the test to ensure accurate results.

The primary focus of this study was to establish the repeatability and accuracy of the print quality measurements offered by the ImageXpert® system. This validation process involved detailed testing under a variety of conditions while recording large amounts of data. A range of instrument performance was defined based on the data collected. Attendees will become familiar with a variety of the print quality measurements tested and the results of the validation process, which will include a detailed listing of error rates corresponding to the tested measurements. The authors will discuss operational limitations and variables that attributed to the error rates. They will also provide insight into the direction of future projects using print quality measurements and the laser height profiling unit.

Questioned Documents, Forensic Document Examination, Travel Documents

J16 The Examination of Permanent Markers Using UV-VIS-NIR Spectrophotometry, Thin-Layer Chromatography and Gas Chromatography-Mass Spectrometry

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After attending this presentation, attendees will learn about the value of UV-visible-near infrared spectrophotometry, thin-layer chromatography and gas chromatography-mass spectrometry to the analysis of questioned documents, specifically to the examination of permanent markers.

This presentation will impact the forensic community and/or humanity by familiarizing the forensic community with the value of UV-visible-near infrared spectrophotometry and with the potential of high-performance thin layer chromatography for forensic analyses.

Permanent markers have been available for decades. They are widely used in homes, offices, and laboratories. Despite the ubiquity of these writing instruments there has been little forensic analysis of their inks. Permanent markers are available in with a variety of tip sizes, ranging from ultra-fine to wide. They are also available with a variety of tip shapes: chisel, bullet, and bristle. The inks in permanent markers consist of dyes and resins dispersed in volatile solvents. The solvent in a permanent marker may be a low-molecular weight alcohol such as n-propanol or a mixture of alcohols (e.g. ethanol and 2-propanol or n-propanol, n-butanol and diacetone alcohol). A series of permanent markers were purchased in the Washington, DC, metropolitan area for analysis. The permanent markers analyzed in this study are listed in the table below.

Brand	Type	Color			
		Black	Blue	Green	Red
Bic	Fine point	X	X	X	X
Fisherbrand	Fine point		X		
Foray Manstays	Chisel point	X	X	X	X
Office	Fine point				
Marks-A-Lot	Chisel point	X	X	X	X
Papermate	Fine point	X	X	X	X
RoseArt	Fine point	X	X	X	X
RoseArt	Retractable, Chisel point	X			
Sharpie	Chisel point	X	X		X
Sharpie	Fine point	X	X	X	X
Sharpie	Twin, fine point		X		
Staples	Chisel point	X	X		X

“Scribble” sheets were prepared with black, blue, green, and red permanent markers on Whatman quantitative hardened low ash grade 54 filter paper (Whatman, Florham Park, NJ). The “scribble” sheets were photographed with a Sony Cyber-shot 5.0 megapixel digital camera equipped with a Carl Zeiss 10X precision digital zoom lens. This camera has infrared capability. The sheets were photographed under normal room light, long wavelength (375 nm) ultraviolet light, green light (570 nm) and infrared light. The green (570 nm) light was provided by a FLS 5000 Forensic Light Source (Evident Crime Scene Products, Union Hall, VA). The “scribble” sheets illuminated with green light were photographed through the red viewing plate provided with the FLS 5000 and through an infrared filter.

Ultraviolet-visible-near infrared reflectance spectra were recorded using a Jasco V-570 Spectrophotometer (Jasco Inc., Easton, MD), equipped with a specular reflectance accessory. Permanent marker ink samples were placed on the dull side of a sheet of aluminum foil. Their spectra were recorded from 200 nm to 2000 nm at a resolution of 0.1 nm. Spectra were recorded in %R mode. The reflectance data were then subjected to a log(1/R) transformation. This transformation has been frequently applied to near infrared spectra because it accentuates subtle differences between spectra.

Samples of the permanent marker inks were also analyzed by thin-layer chromatography (TLC). Six-millimeter diameter disks were punched out of the scribble sheets with a single-hole punch. The disks were divided in half and one half was extracted with 20 µL of methanol. The 20-µL extracts were spotted on Silica Gel 60 TLC plates without fluorescent indicator (EMD Chemicals, Gibbstown, NJ). Extracts were similarly spotted on high-performance thin-layer chromatography (HPTLC) plates (EMD Chemicals, Inc., Gibbstown, NJ). The TLC and HPTLC plates were developed in an ethyl acetate:ethanol:water (75:35:30) mobile phase. The TLC plates were allowed to develop over a 10-cm distance, while the HPTLC plates were allowed to develop over a 5-cm distance. The developed TLC and HPTLC plates were photographed under normal room light, long wavelength (375 nm) ultraviolet light and infrared light.

The permanent markers were also analyzed by gas chromatography-mass spectrometry (GC-MS). Six millimeter disks were punched from the scribble sheets and extracted with 40 µL of methanol. A 1-µL aliquot of the extract was injected into a Varian Saturn 2000 gas chromatograph-mass spectrometer. A 30-m Restek Rtx-1MS capillary column with a 0.25 mm internal diameter and 0.5 µm film thickness was used. The injector and transfer line temperatures were 250°C and 270°C, respectively. The following column oven temperature program was used: 50°C for 1 min, 10°C/min ramp to 200°C and a 2-min hold at the final temperature. A 2 ¾ min solvent delay was also incorporated into the GC-MS method of analysis. Mass spectra were scanned from 10 m/z to 650 m/z.

Examination of the permanent markers under the different illuminants had limited value for the discrimination of black permanent markers. Under visible light the black permanent markers could not be differentiated from one another. Two black permanent markers were effectively transparent to infrared light. The different illuminants did provide somewhat better discrimination of the colored permanent markers; nevertheless, a number of the colored permanent markers could not be distinguished from one another.

The ultraviolet-visible-near infrared reflectance spectra allowed a high degree of discrimination of the colored permanent markers. The reflectance spectra of the black permanent markers fell into three groups. In Group 1, the visible-near infrared reflectance changed abruptly from low reflectance to high reflectance between 600 and 800 nm; in Group 2, the reflectance increased slowly between 600 nm and 1000 nm; and in Group 3, the reflectance remained low between 600 nm and 1000 nm. The visible-near infrared reflectance spectra of black gel pen inks have been observed to behave in a similar fashion.

TLC was able to differentiate all of the permanent markers except for the Foray and Staples black, blue, and red markers and the Bic and

Sharpie red markers. The HPTLC plates developed in approximately one third the time required for the regular TLC plates but showed the same resolution of the permanent marker dyes.

In general, GC-MS was not highly discriminating of the permanent markers. Their total ion chromatograms typically showed only one or two major components. The Foray and Staples black, blue, and red +permanent markers, which could not be discriminated by TLC, could also not be differentiated by GC-MS. These markers are “house brand” markers produced in China. It is possible that the Foray and Staples markers were actually produced by the same Chinese company from the same ingredients. The Bic and Sanford Sharpie red permanent markers could be differentiated by GC-MS: their chromatograms contained different components. The identification of the permanent marker components appearing in the GC-MS chromatograms is on-going.

This research shows that TLC has the greatest power to discriminate between permanent markers. When TLC fails to differentiate permanent markers, GC-MS may provide additional useful information.

GC-MS, TLC, HPTLC

J17 Color Region Segmentation Based on RGB Vector Space

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The goals of this presentation are to improve the credibility of forensic image processing, and to facilitate questioned documents examination.

This presentation will impact the forensic community and/or humanity by greatly improving the credibility of image processing on evidence of questioned documents.

By the digital technology progressing, using digital image processing technology on questioned documents is more frequent and important for the document examiners. Specially, in forensic image processing, it is often important to be able to separate a feature from an interfering background or foreground.

This study proposed a method of color region segmentation based on RGB vector space for applying forensic documents. Segmentation is a process that partitions an image into regions. Color region segmentation using RGB color vectors is straightforward. Suppose that the objective is to segment objects of a specified color range in an RGB image. An estimate must be obtained of the “average” or “mean” color that is to be segmented. The objective of segmentation is to classify each RGB pixel in an image as having a color in the specified range or not. So, need a measure of similarity such as the Euclidean distance is needed. Consequently, the key issue in this approach is how to estimate a specified threshold that can separate effectively different objects on questioned documents, and then it makes the examiners to inspect clearly objects including handwriting, stamp inks etc.

In conclusion, the researcher’s experimental results demonstrate that the above new method can be used successfully to segment several objects of forensic images, and it greatly improves the credibility of image processing on evidence of questioned documents.

Color Region Segmentation, RGB Vector Space, Questioned Documents



K1 Analysis of Anabolic Steroids in Urine by LC/MS/MS

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After attending this presentation, attendees will learn of an LC/MS/MS technique for analyzing anabolic substances in urine.

This presentation will impact the forensic community and/or humanity by demonstrating how to quantitate steroids in urine using a non GC/MS technique, which can save additional sample preparation steps including derivatization.

This work represents the use of LC/QQQ mass spectrometry for confirmation of performance-enhancing drugs in urine, targeted for sports doping control analysis. LC/MS/MS with a high-performance 3.5 μ m rapid resolution column and ionization by APCI on the QQQ instrument, using MRM analysis, provides a lower-cost alternative to the current de-facto standard in international doping control, which is the EI-GC/MS high-resolution magnetic sector instrument. Additionally, increased throughput as a result of bypassing the necessary sample derivatization step, without sacrificing the sensitivity required to meet the minimum required performance levels (MRPLs) of the World Anti-Doping Agency (WADA), is also considered an advantage. Confirmation is carried out using designated quantitation ions in MRM mode. Samples were obtained from the Center for Human Toxicology (University of Utah) to generate calibration curves for quantitation.

The samples were prepared by a liquid/liquid extraction of 3 mL of control urine, spiked at specified levels. The extractions were evaporated to dryness and then reconstituted in 100 μ L of liquid chromatographic (LC) mobile phase solvent. The compounds analyzed include 4 α -stanozolol, 19-nor-etiocholanolone, tetrahydrogestrinone (THG), and epimetendiol, with internal standards such as methyltestosterone, and d5-etiocholanolone. Calibration curves were generated over concentrations ranging from $\frac{1}{2}$ x to 10 x MRPLs with linearity coefficients (r^2 values) greater than 0.997. Reproducibility at the lowest level ($\frac{1}{2}$ x MRPL) was measured in terms of percent relative standard deviation (% RSD) of peak area counts for repeated injections. For triplicate injections the percentage RSDs were typically 1 – 6 %.

The signal-to-noise (S/N) was calculated by first selecting a region of the chromatogram from which to determine the root-mean-squared (RMS) noise, which was then multiplied by a factor of five. The S/N was therefore the height of the peak divided by 5 x RMS noise. This was equivalent to peak-to-peak noise. The limit of detection (LOD) was calculated by first determining the S/N for the peak at the $\frac{1}{2}$ x MRPL and then scaling the concentration down to a level that corresponds to S/N = 3. For example, in the case of epimetendiol, the estimated LOD was 0.05 ng/mL in urine, or 3 pg on-column for a 2 μ L injection volume.

LCMS, QQQ, Steroids

K2 The Analysis of Workplace Urine Specimens From Federal Employees Reported as Rejected for Testing

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After attending this presentation, attendees will have a better understanding of the drug and validity characteristics of Federal employee urine specimens that were not tested & reported as Rejected for Testing.

This presentation will impact the forensic community and/or humanity informing the forensic community with objective data for Federal employee workplace urine drug testing specimens reported as Rejected for Testing at two SAMHSA certified laboratories and allow the re-evaluation of minimum drug testing volume requirements.

Introduction: Anecdotal comments infer that the incidence of drug positivity and/or unacceptable specimen validity in specimens that would be routinely reported as Rejected for Testing, mostly due to volume less than 30 mL, is considerably higher than in those specimens that had sufficient volume to routinely test. These anecdotes apply generally to workplace urine drug testing and also specifically to specimens tested under Federal authority.

Objective: To determine if Federal employee specimens that were reported as Rejected for Testing by SAMHSA certified laboratories provided similar drug positive, adulterated, invalid, or substituted (non-negative) results when compared to the results of other federally regulated specimens that were tested and reported over the same time frame in SAMHSA certified laboratories.

Methods: Specimens submitted through the Federal employee drug testing program and reported as Rejected for Testing were obtained from two SAMHSA certified laboratories, with no way to link the specimens to donors. The specimens (both A and B bottles, when available) were tested with a Microgenics MGC240 using Microgenics DRI (Cannabinoid Metabolites, Cocaine Metabolite, Phencyclidine, Opiates, Amphetamines), Microgenics Detect (Creatinine, pH) and Axiom (Oxidant) assays. Those specimens for which drug tests were presumptively positive by immunoassay and for which validity tests were not within the acceptable range as required in the Mandatory Guidelines (69 Fed. Reg. 19644, effective Nov. 1, 2004) were sent to a reference laboratory for confirmatory drug tests by GC/MS and necessary validity testing in accordance with those Mandatory Guidelines.

Results: Specimens from 478 donors that had been reported as Rejected for Testing from November 2004 through April 2006 with a volume of at least 5 mL were tested. Of these 478 donor specimens, 63 donors provided specimens with either presumptive drug positive results and/or unacceptable validity test results, including dilute. Of these 63 donor specimens, 11 donors provided drug negative dilute specimens that were not tested further for drugs below the Mandatory Guidelines cutoffs, 45 donors provided specimens having a single presumptive drug positive result or unacceptable validity test results. Confirmatory testing of these 45 specimens yielded the following results:

	AMP	BZE	OPI	PCP	THCA	ADULT	INV	SUBS	Total
Screened (+)	14	4	6	0	6	0	15	0	45
Confirmed (+)	8	4	6	NA	6	NA	15	NA	39

Of these 63 donor specimens, seven donors provided specimens with multiple results: multiple presumptive drug positives, multiple unacceptable validity test results, or a combination of presumptive drug positive and unacceptable validity test results. Confirmatory testing of these seven specimens yielded the following results:

Positive Screening Test	ADULT/ INV	AMP/ BZE	AMP/ OPI	AMP/ THCA	BZE/ DIL	BZE/ THCA	OPI/ THCA
Confirmatory Test Results	pH too high	AMP MAMP	NEG AMP NEG MAMP	AMP MAMP	BZE	BZE	NEG MOR NEG COD
	Abnormal Creat&SpGr	BZE	COD MOR	THCA	DIL	THCA	THCA

Only 13 of the 478 specimens reported as Rejected for Testing were collected under Post-Accident or Reasonable Suspicion/Cause conditions. One of those 13 donors provided a dilute specimen. Specimens from three of these 13 donors (23.1%) provided drug positive results: two donors were positive for THCA, and one donor was positive for both BZE and THCA. Of the specimens provided by the 478 donors, 9.6 % (46) provided specimens with drug positive and/or unacceptable specimen validity results (not including the 11 dilute specimens) as compared to 2.2% of all Federal & federally regulated specimens tested and reported by all SAMHSA certified laboratories during the same time period that were also tested for drugs and specimen validity (not including dilute results).

Conclusions: Of the 478 specimens reported as Rejected for Testing, 353 were rejected for insufficient volume (< approximately 30mL), with only 18 of these 353 specimens having leaked in transit resulting in their insufficient volume. This suggests that the minimum volume requirement for specimen rejection may need to be re-evaluated.

Rejected Specimens, Federal Employees, Non-Negative Incidence

K3 Alcohol, Drugs, and Homicide

Xiang Zhang, MD, and Ling Li, MD, Office of the Chief Medical Examiner, 111 Penn Street, Baltimore, MD 21201; Ping Yan, MD, Department of Forensic Medicine, Wuhan University, Wuhan, Hubei 430072, China; Barry S. Levine, PhD, and David R. Fowler, MD, Office of the Chief Medical Examiner, 111 Penn Street, Baltimore, MD 21201*

After attending this presentation, attendees will better understand the role of alcohol and drug abuse in violent deaths.

This presentation will impact the forensic community and/or humanity by providing additional support that alcohol and drug users are at greatly increased risk of being victims of homicide.

In the United States, homicide is the third leading cause of death for persons 15-24 years of age and the leading cause of death for black males 15-34 years of age. It has been estimated that one out of ten homicide victims are drug-related.

A retrospective study of homicide victims in the State of Maryland was conducted for 2003, 2004, and 2005 to determine alcohol and/or illicit drugs use among homicide victims. During the past three years, a total of 1,674 homicides occurred in Maryland, with an average rate of 10.1 homicides per 100, 000 individuals. Males were six times more likely to become homicide victims (85.7%) than were females (14.3%). Blacks were 5.9 times more likely than whites to be victimized. Black males were at the greatest risk, to become victims. Of homicide victims, 71 % (1187/1674) were black males, with an average rate of 53.5 per 100,000 populations.

Comprehensive alcohol and drug testing were performed on all of the homicide victims. Alcohol and /or drugs were found in a significant portion of homicide victims. Of this group, 739 out of 1,674 homicide victims (44%) showed some form of recent illicit drug and/or alcohol use. Alcohol was positive in 33% of the cases. Among illicit drugs, cocaine was the most common drug detected in the homicide victims (15%), followed by Narcotics (6%), Phencyclidine (PCP) (3%), and Methylenedioxyamphetamine (MDMA) (1%). More male victims (46%) were positive for alcohol and/or drugs than were female victims (22%). Blacks (45%) were slightly more likely than whites (41%) to be positive for alcohol and/or drugs.

The most common cause of homicide in Maryland was firearm injury (77%), followed by sharp force injury (10%), blunt force injury (8%), suffocation/strangulation (2%). Among victims caused by firearm injury, 34% were positive for alcohol, 10% for cocaine, 7% for narcotics, 4% for PCP, and 1% for MDMA. The victims from sharp force injury were 33% positive for alcohol, 7% for cocaine, 2% for narcotics, and 1% for PCP. Alcohol, cocaine, and narcotics were detected in 25%, 6%, and 6% respectively among victims of blunt force injury, and in 36%, 3%, and 11% respectively among the victims from suffocation/strangulation.

Forensic Toxicology, Drugs, Homicide

K4 Gamma-Hydroxybutyrate (GHB) - Withdrawal With Severe Rhabdomyolysis, Hyperkalemia, and Cardiac Arrest

David M. Benjamin, PhD, 77 Florence Street, Suite 107, Chestnut Hill, MA 02467*

After attending this presentation, attendees will learn about the presentation of severe GHB withdrawal.

This presentation will impact the forensic community and/or humanity by informing the forensic community that severe GHB toxicity leading to death can occur in the absence of proper treatment.

Gamma-Hydroxybutyrate (GHB) is well known to the forensic toxicology community for its euphoric, soporific, and intoxicating properties. Fatalities have occurred from recreational use of GHB at clubs or "Raves," and when GHB has been added surreptitiously to another person's beverage, usually to facilitate a sexual assault (Drug Facilitated Sexual Assault, DFSA). However, chronic use of GHB produces a dependence similar to that of ethanol, and a withdrawal syndrome very similar to ethanol-related delirium tremens (DTs) has been reported in the literature.

In this case, the decedent was a 28-year-old a male with a long-term, high dose dependence on GHB. In order to ensure his supply of GHB, the man distributed GHB. At the time of his cardiac arrest, the decedent was in police custody for possession and trafficking of GHB. During the booking process, the decedent complained of symptoms of GHB withdrawal. Over a further two-day period of abstinence, the decedent became disoriented, agitated, began to hallucinate and injure himself. To prevent further injury, he was restrained in a "pro-strait" chair with restraints at the wrists, chest, and ankles. The next day, he was less combative but continued to have hallucinations and exhibit rambling speech. After 22.5 hours, he was released from restraints and transferred to a soft-walled cell equipped with video monitoring. He subsequently was observed walking around the cell, but by the end of the second hour, he was observed slumped in the corner of his cell. Guards entered the cell and found him unresponsive, pulse less and apneic. EMS personnel were summoned and also reported him as pulse less and apneic, with a cardiac monitor indicating pulseless sinus tachycardia. CPR was started, the patient was intubated and given naloxone and dopamine, and he was transported to the hospital emergency room (ER).

In the ER, the patient was initially hypotensive but his blood pressure stabilized and dopamine was tapered and stopped. A CAT scan of the head and chest x-ray were normal. However, serum potassium was 8.0 mEq/L, urea nitrogen was 97, serum creatinine was 4.1 and creatine phosphokinase (CPK) was 75,000 IU/L with a heart muscle fraction (CK-MB) of 0.3%. Serum troponin was negative. Urine drug screening was negative for ethanol, salicylates, phencyclidine, cocaine, amphetamines, cannabinoids, opiates, barbiturates, and tricyclic antidepressants. Urine drug screening was positive for benzodiazepines. The admitting MD's assessment was cardiac arrest, probably secondary to acute hyperkalemia and secondary to acute renal failure secondary to rhabdomyolysis secondary to polydrug abuse; liver failure; coagulopathy; and respiratory failure. The patient's clinical course worsened. He became increasingly anuric and his CPK continued to rise along with liver function tests. Four days after admission to the ER, a follow up CAT scan of the head showed diffuse cerebral edema with herniation which led to his being declared brain dead. Autopsy findings included anoxic encephalopathy, cerebral edema, herniation, and necrosis of the cerebellar tonsils, secondary compression, and necrosis of the cervical spine; rhabdomyolysis with necrosis of skeletal muscle cells; acute renal failure with acute renal tubular necrosis of kidneys; bronchopneumonia, and centrilobular necrosis of the liver (shock liver). The cause of death was listed as anoxic encephalopathy following resuscitation from cardiac arrest due to GHB withdrawal syndrome, and the manner of death was listed as natural. The Medical Examiner offered the following comment in his report: "The suddenness of collapse and development of rhabdomyolysis are suggestive of seizures as the mechanism of cardiac arrest during withdrawal in this case." Neither the record of incarceration nor video monitoring included any reference to a witnessed seizure. There were no bite marks on the tongue. The ME was on the right track, but has not quite accounted for the markedly elevated CPK and muscle death which led to the liberation of sufficient intracellular potassium to raise normal serum potassium levels (3.5-5.3 mEq/L) up to 8.0 mEq/L and cause a cardiac arrest.

The key to understanding this case was the development of rhabdomyolysis with the associated release of myoglobin that got trapped in the kidneys' glomeruli and caused renal failure which potentiates the hyperkalemia caused by release of potassium from intracellular sites in skeletal muscle cells. While a seizure can cause both hyperpyrexia and physical damage to muscle cells, the order of magnitude of the cell death and associated hyperkalemia that led to this patient's death indicated massive muscle death and release of sufficient potassium to raise serum potassium approximately 3 mEq/L. A better explanation for the massive tissue damage would be the hyperpyrexia and dehydration generated from agitation and "fighting with the restraints." Elevated catecholamine and potassium levels are often cited as possible physiological triggers; however, GHB can also cause DTs similar to those of ethanol withdrawal, which include autonomic hyperactivity and typically occur 72-96 hours following abstinence.

Gamma-Hydroxybutyrate (GHB) Withdrawal, Rhabdomyolysis, Hyperkalemia

K5 Recent Paramethoxymethamphetamine (PMMA) Deaths in Taiwan

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After attending this presentation, attendees will learn about: 1) the action of PMMA; 2) a sensitive GC/MS method for the analysis of PMMA; and 3) the concentration of PMA and PMMA in postmortem specimens.

Trafficking of PMA and PMMA tablets are found in Taiwan from December 2005 to March 2006. Five deaths caused by acute toxicity of PMA and PMMA in April have posed a threat to the society in Taiwan because people are unaware that PMMA in combination with PMA are sold as Ecstasy. PMA is classified as Schedule II controlled drug but PMMA has not been classified as a controlled substance in Taiwan. This presentation will impact the forensic community and/or humanity by presenting the need to bring PMMA as Scheduled II controlled drugs and also to impose criminal penalties through legislation.

Paramethoxyamphetamine (PMA) and paramethoxymethamphetamine (PMMA) are methoxylated phenylethylamine derivatives that have been banned in Taiwan since December 2005. Case history and pathological and toxicological findings of eight recent PMMA fatalities were investigated. All specimens from these cases were initially identified by AxSYM fluorescence polarization immunoassay screening test for amphetamines with a 300 ng/mL cutoff. Specimens screened positive were confirmed and quantitated by gas chromatography-mass spectrometry. The mean age of these PMMA-related fatalities was 18.9 ± 4.4 years ranging from 14–25. Seven (87.5%) of these eight cases were men. The mean, standard deviation, and range of PMA found in the heart blood collected from these eight cases were 0.213, 0.144, and 0.079–0.489 µg/mL; the corresponding data for PMMA were 4.312, 4.806, and 1.208–15.824 µg/mL, respectively. Other drugs, such as MDA, MDMA, ketamine, norketamine, hydroxymidazolam, methamphetamine, and pentobarbital, were also found in these cases. This paper describes five cases of fatal overdose from PMMA ingestion that occurred in April 2006 in Taiwan. These cases reflect the well-known fact that street drugs offered as ecstasy pills do not necessarily contain MDMA, but frequently differ in composition even if they have the same logo. Users of these pills therefore always take the risk of consuming pills with dangerous life-threatening ingredients.

Forensic Toxicology, PMMA Deaths, Drug of Abuse

Table I. Postmortem Distribution of PMA and PMMA ($\mu\text{g/mL}$) Found in Specimens Collected from Eight Fatal Cases in Taiwan.

Case	Age	Sex	Drug Ratio	Heart Blood	Urine	Other Drugs (Blood, $\mu\text{g/mL}$)	Cause of Death	Manner of Death
1	14	M	PMA PMMA PMA/PMMA	0.145 3.017 0.048	6.263 157.51 0.040	Ketamine, 0.018 Norketamine, 0.017	PMMA intoxication	Accidental
2	15	M	PMA PMMA PMA/PMMA	0.196 1.554 0.126	1.808 7.646 0.237	ND ^a	PMMA intoxication	Accidental
3	18	F	PMA PMMA	0.367 15.824	— ^a —	Ketamine, 1.210 Norketamine, 0.558	PMMA intoxication	Suicide
4	19	M	PMA PMMA PMA/PMMA	0.489 4.014 0.122	— — NA	Methamphetamine, 0.139 Pentobarbital, 0.283 intoxication	PMMA	Accidental
5	25	M	PMA PMMA PMA/PMMA	0.122 1.208 0.101	0.379 11.857 0.032	MDMA, 0.199 Ketamine, 0.154 Norketamine, 0.177	PMMA intoxication	Accidental
6	14	M	PMA PMMA PMA/PMMA	0.205 2.193 0.093	5.964 88.706 0.067	Methamphetamine, 0.109 MDA, 0.134 MDMA, 14.637 Ketamine, 0.199 Norketamine, 0.326	Multiple-drug intoxication	Accidental
7	22	M	PMA PMMA PMA/PMMA	0.097 1.969 0.049	0.263 14.208 0.019	Ketamine, 0.041	PMMA intoxication	Accidental
8	24	M	PMA PMMA PMA/PMMA	0.079 4.718 0.017	— — NA	MDA, 0.172 MDMA, 4.322	Multiple-drug intoxication	Accidental

^a ND: Not detected; NA: Not applicable; —: Sample (or information) not available.

K6 Cocaine Impaired Driving: Evaluation of Toxicology, Driving Behavior, and Impairment Symptoms in Arrested Drivers

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The goal of this presentation is to evaluate common observations, driving behavior, and impairment symptoms in actual drivers that have used cocaine and are apprehended for driving while intoxicated (DWI).

This presentation will impact the forensic community and/or humanity by assisting with the toxicological interpretation of cases by comparing common signs, symptoms, observations and driving behavior in drivers suspected of driving under the influence of cocaine.

Driving behavior, reason for the traffic stop, documented signs and symptoms and quantitative blood toxicology are compared in a series of 48 persons suspected of driving under the influence of cocaine.

Cocaine is a central nervous system stimulant, which at high doses can produce characteristic physiological and behavioral effects that are inconsistent with safe driving. However, many scientific studies are limited by the low dose of drug that is administered to human subjects,

doses that typically much lower than those used by illicit drug users. Multiple drug use, tolerance, dependence, and withdrawal effects of the drug make interpretation of these cases challenging. In many instances, toxicologists take a case-by-case approach to impairment by drugs other than alcohol. This process involves a careful review of toxicology test results, driving and observations that were made by law enforcement personnel.

In this series of 48 drivers, only 10 cases involved cocaine alone. The remaining 38 cases involved multiple drug use, most frequently ethanol, marijuana, benzodiazepines, and methadone. Mean, median and mode cocaine concentrations were 0.09 ± 0.12 (SD), 0.05 and 0.02 mg/L respectively. Mean, median and mode benzoylecgonine (BE) concentrations were 0.81 ± 0.94 (SD), 0.43 and 0.14 mg/L respectively. The total range of concentrations for cocaine and BE for all the cases (n=48) were 0.01-0.53 and 0.03-4.10 mg/L respectively. Comparison of quantitative drug results for cocaine only and cocaine in combination with other drugs indicated no significant differences. The most common reason for the traffic stop was a crash. Other common reasons for the stop were notification by dispatch (following a report of impaired driver from the public) and impaired speed control. The performance on standardized field sobriety tests (SFSTs), which can provide important information on mental and physical function, were evaluated for all the cases. SFSTs were not performed in every case due to injuries sustained in a crash, uncooperative subjects, or subjects that were too impaired to

safely perform the tests. Documented signs, symptoms, and observations made by the arresting officer were compared. The most common observation for both cocaine only and cocaine in combination with other drugs was impaired psychomotor function.

Cocaine, Impaired, Driving

K7 Driving Under the Influence of Methamphetamine: Comparison of Driving Behavior and Impairment Symptoms in Subjects Arrested for Driving While Intoxicated (DWI)

Sharla McCloskey, BS, Anna Leggett, BS, Rachael Malfer, and Sarah Kerrigan, PhD, Sam Houston State University, College of Criminal Justice, 1003 Bowers Boulevard, Huntsville, TX 77341*

The goal of this presentation is to review driving behaviors and impairment symptoms in a series of sixty drivers suspected of driving under the influence of methamphetamine.

This presentation will impact the forensic community and/or humanity by assisting with the toxicological interpretation of cases by comparing common signs, symptoms, observations and driving behavior in drivers suspected of driving under the influence of methamphetamine.

In drug impaired driving cases, a toxicologist usually requires information from a variety of sources before they provide an opinion regarding possible impairment. Information in the police report, such as the reason for the stop, performance on the standardized field sobriety tests and other observations made by law enforcement or witnesses at the scene can be of interpretive value. A series of sixty drivers who used methamphetamine and were subsequently arrested for driving under the influence of drugs (DUID) are presented.

Methamphetamine is a central nervous system stimulant that can produce wide-ranging effects, depending on the dose and phase of use. At high doses methamphetamine has the potential to impair skills that are important for safe driving. Quantitative blood drug results are valuable from a toxicological standpoint but must be interpreted within the context of the case. Low concentrations of the drug in the later phase of drug use (down-side) can produce effects that are detrimental to safe driving. Multiple drug use, tolerance, dependence, and withdrawal effects of the drug make interpretation of these cases challenging.

In this series of 60 drivers arrested for DWI, quantitative blood methamphetamine concentrations were reviewed, together with the reason for the stop, signs, symptoms, performance on standardized field sobriety tests, and other observations. Cases involving only methamphetamine were compared with methamphetamine in combination with other drugs. Mean, median and mode blood methamphetamine concentrations were 0.3, 0.2 and 0.1 mg/L (n=60) respectively. Amphetamine was detected in blood samples in 42 of the cases and reported quantitatively in 28. Concentration ranges for methamphetamine and amphetamine were 0.01-3.20 and 0.02-0.26 mg/L respectively. The reason for the stop, performance on field sobriety tests and roadside observations were compared for different sub-sets of data that were organized by concentration and drugs present. The most common reasons for the traffic stop were a crash (n=18), equipment violation (n=13), erratic driving (n=9) and notification by dispatch (n=8). The performance on standardized field sobriety tests were evaluated in terms of the number of clues, together with other observations, the most common of which were bloodshot eyes and impaired balance and coordination. Individual cases are presented to illustrate some of the common interpretive challenges including tolerance, withdrawal and the phase of drug use within the context of quantitative drug toxicology.

Methamphetamine, Impaired, Driving

K8 Driving Behavior and Impairment Symptoms in Cannabinoid Positive Subjects Arrested for Driving Under the Influence of Drugs (DUID)

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The goal of this presentation is to review driving behaviors and impairment symptoms in a series of 108 cannabinoid positive drivers suspected of driving under the influence of drugs.

This presentation will impact the forensic community and/or humanity by assisting with the toxicological interpretation of cases by comparing common signs, symptoms, observations and driving behavior in drivers suspected of driving under the influence of marijuana.

Quantitative drug toxicology is complemented by case specific observations, such as performance on field sobriety tests, signs, symptoms and other observations made by qualified law enforcement personnel. Quantitative blood drug results and supplemental information are presented in a series of 108 cannabinoid positive drivers.

Marijuana can produce a unique spectrum of effects that prevents classification into only one class. From an impaired driving standpoint however, scientific studies have shown that delta-9-tetrahydrocannabinol (THC) can impair cognitive and psychomotor functions associated with driving in a dose dependent manner. Yet, there is no widely accepted concentration of THC in blood at which a driver is deemed impaired for the purposes of driving. Quantitative blood toxicology is important in DUID cases involving cannabinoids, but must be carefully interpreted within the context of case specific information and the collection time, due to the rapid decline of THC in blood following smoking. Interpretation is further complicated by the frequency of multiple drug use among impaired drivers, particularly those using cannabinoids.

In a series of 108 drivers arrested for DWI, quantitative blood cannabinoid concentrations were reviewed, together with the reason for the stop, signs, symptoms, performance on standardized field sobriety tests, and other observations. Cases involving only cannabinoids were compared with cannabinoids in combination with other drugs. Mean, median and mode 11-nor-9-carboxy-delta-9-THC (carboxy-THC) concentrations were 39, 29 and 7 ng/mL (n=108) respectively. THC was detected in 50 of the cases and reported quantitatively in 45, with a mean, median, and mode of 5, 4 and 3 ng/mL respectively. Concentration ranges for THC and carboxy-THC were 2-18 and 2-235 ng/mL respectively. The limit of quantitation of the method was 2 ng/mL. The reason for the stop, performance on field sobriety tests and roadside observations were compared for different sub-sets of data that were organized by presence of parent drug (THC) and other drugs present. The three most common reasons for the traffic stop were speeding (n=30), crash (n=25) and weaving (n=21). The performance on standardized field sobriety tests were evaluated in terms of the number of clues, together with other observations, the most common of which were impaired balance and coordination (n=54), bloodshot eyes (n=50), watery/glassy eyes (n=32) and slurred or thick speech (n=26).

Marijuana, Impaired, Driving

K9 Fatal Ephedrine Intoxication in a Chronic Ephedrine User Who Had Cardiovascular Disease

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After attending this presentation, attendees can be expected to enhance their understanding of the possible risk factors for fatal ephedrine intoxication.

This presentation will impact the forensic community and/or humanity by providing additional information to the public indicating a possible risk factor associated with the use of a drug commonly found in dietary supplements.

Introduction: Ephedrine is an alkaloid present in some dietary supplements which has been widely used for body weight reduction and energy enhancement. Although serious adverse reactions have been described in the literature, there is still some controversy over the prevalence of such adverse events and the factors that increase the risk to users of the drug. This presentation describes a fatal ephedrine intoxication in a subject who had arteriosclerotic cardiovascular disease.

Case Study: A 40-year-old male Caucasian was found unconscious and a resuscitative attempt was unsuccessful. The decedent was reported to have used the non-prescription drug "MaxAlert" that purportedly contains 25 mg ephedrine hydrochloride and 100 mg guaifenesin per tablet¹.

An autopsy, conducted approximately 9 hours postmortem, revealed arteriosclerotic cardiovascular disease with the left anterior descending artery 60% occluded with plaque and the right coronary artery 100% occluded. The heart weighed 550 grams. Examination of other organs, including neuropathological analysis of the brain, was unremarkable. Toxicological analysis of cardiac blood was negative for alcohol and disclosed the presence of ephedrine (10.0 mg/L) and phenylpropanolamine (0.8 mg/L). The urine tested positive for ephedrine and phenylpropanolamine.

Toxicological results of autopsied brain and scalp hair: Hair strands, cut close to the scalp, were individually aligned (root-to-tip) and segmented into one inch segments. The resulting three segments were sequentially washed with 3 x 1 mL 1% SDS, 3 x 3 mL MilliQ water, 3 x 3 mL methanol². Deuterated internal standards were added to 20-mg hair, followed by addition of 2 mLs 0.1 N HCl, and subsequent overnight incubation at 37° C. Specimens were buffered to pH 5.5, extracted with a solid-phase procedure, and screened for a panel of selected drugs by liquid chromatography (LC) atmospheric pressure ionization - electrospray (API - ES) mass spectrometry (MS). Ephedrine and methamphetamine, respectively, were detected at the following concentrations: Segment #1, 34.3, and 1.6 ng/mg; Segment #2, 35.9 and 1.8 ng/mg; Segment #3, 41.9 and 1.6 ng/mg hair.

Tissue homogenates (occipital cortex) were also prepared, deuterated standards added, and specimens immediately extracted using the extraction and MS procedures described above with minor modifications. Ephedrine alone was detected in brain at 10.2 ng/mg tissue.

Discussion: The results of the toxicological analyses indicate that the subject used ephedrine both acutely (blood and brain drug positive) and chronically (hair segments drug positive). In addition, the analyses disclosed evidence of some chronic, but not acute, exposure to methamphetamine.

It was proposed at the 2004 AAFS workshop on ephedrine that toxicity to the drug might commonly occur in asymptomatic individuals who have an undiagnosed underlying disease. The findings of the case study are consistent with this possibility as the autopsy disclosed severe cardiovascular disease, a condition that would be expected to predispose the drug user to complications arising from the sympathomimetic property of ephedrine. Nevertheless, the alternate possibility has to be considered that the high concentration of ephedrine found in the deceased could have been sufficient, on its own, to have caused death. In this regard, the concentrations of ephedrine found in blood and brain of this case are similar to those reported in a fatal ephedrine intoxication in which no underlying pathology could be observed at autopsy³.

The final cause of death was ruled for this case to be ephedrine intoxication and arteriosclerotic heart disease.

Conclusion: The case study finding provides additional support to the proposal that fatal ephedrine intoxication can occur in a subject having underlying cardiovascular disease.

References:

¹ http://www.fda.gov/foi/warning_letters/d1218b.pdf

² *J Forensic Sci* 2004;49:1106-12.

³ *J Forensic Sci* 1997;42:157-9.

Ephedrine, Cardiovascular, Fatality

K10 Intoxilyzer® 8000 Stability Study

John J. Kucmanic, BS*, Ohio Department of Health, 161 South High Street, Akron, OH 44308

After attending this presentation, attendees will gain valuable information about the stability and performance of one model of breath alcohol instrumentation.

This presentation will impact the forensic community and/or humanity by adding additional analytical validity to the alcohol results reported from the Intoxilyzer® 8000 which will aid state programs and prosecutors in convicting drunk drivers.

This study was conducted to investigate the performance and stability of the Intoxilyzer® 8000 operated in either the Alternating Current (AC) or Direct Current Battery (DC_{BT}) mode over a period of one year when the light source remained illuminated.

During this testing period, the light source remained on for 341 days which amounted to greater than 8,184 hours of source/detector life. Furthermore, the instrument detector voltages for both filters were documented for over 240 days to monitor the stability of light source over the evaluation period.

Instrument checks were performed at random intervals to verify the accuracy and precision of the instrument. Each testing day 20 consecutive instrument checks were run in the AC mode followed by 20 consecutive tests using DC_{BT} mode. A total of 4,820 tests were performed on one Intoxilyzer® 8000 using an Instrument check solution lot with a target value of 0.099 g/210L. The statistical mean, median, and mode derived from the analysis of all tests were identical to the target value.

The Intoxilyzer® 8000 pulsed light source/detector is robust and over a period of one year of operation was able to produce acceptable results for the instrument check solution tested in either the AC or DC_{BT} mode with no appreciable loss of calibration or precision.

Intoxilyzer® 8000, Alcohol, Breath Testing

K11 Simultaneous Screening and Confirmation of Drugs in Biological Fluids Utilizing LC/MS/MS

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After attending this presentation, attendees will understand a simple method used to detect and confirm the presence of drugs of abuse and their metabolites in various biological matrices. This method has very simple sample preparation and can detect and identify drugs across several different compound classes.

This presentation will impact the forensic community and/or humanity by demonstrating the ability of toxicologists to screen samples in a simpler and quicker manner. They also will have the capability to screen across several drug classes in a single experiment.

Rapid detection, identification, and quantification of drugs in biological matrices are important aspects of forensic toxicology. Typically, GCMS, HPLC, immunoassays, TLC, and various other methods are used to screen for drugs and GC/MS is used confirmation of drugs in Forensic analysis. The use of LC/MS/MS for screening, confirmation, and quantitation of drugs in toxicological assays is becoming increasingly common due to the simplicity, selectivity, and sensitivity of the technique.

A simple LC/MS/MS method was developed to analyze biological fluids (urine, blood, and oral fluids) for hundreds of common drugs of abuse and/or their metabolites, including opioids (including Fentanyl), sympathomimetic amines, antidepressants, benzodiazepines, cocaine, and THC. A hybrid triple quadrupole/linear ion trap mass spectrometer was used for detection, which allowed confirmation using full scan MS/MS spectra and quantitation using multiple reaction monitoring (MRM). Detection limits for all analytes can be as low as pg/mL range. Sample preparation was eliminated or greatly simplified versus analogous experiments using other chromatographic techniques and experimental run times were on the order of 10 - 15 minutes.

Toxicology, Drug Screening, LC/MS/MS

K12 A Novel Method to Extend the Detection Window of Drug Administration in Victims of Malignant Assault With Hybrid LC/MS/MS Technology Combining Triple Quadrupole and Ion Trap Technology

Andre Schreiber, PhD, Applied Biosystems/MDS Sciex, 71 Four Valley Drive, Concord, Ontario L4K4V8, Canada*

After attending this presentation, attendees will understand the advantages of using hybrid triple quadrupole linear ion trap mass spectrometry to identify phase I and phase II metabolites of drugs.

This presentation will impact the forensic community and/or humanity by helping to determine whether a drug has been administered, even after the parent drug has been completely eliminated from the victim's body.

A research method has been developed to detect drug intake long after a dose has been administered. This is achieved by detecting specific Phase I and Phase II metabolites that are continually excreted post dose, far longer than the parent drug. Drugs and metabolites are detected in positive mode utilizing specific Multiple Reaction Monitoring (MRM) experiments. Information-dependent criteria for acquisition of an enhanced product ion (EPI) scan result in precursor ion fragmentation to characteristic product ions. Fragmentation occurs at varying collision energies and enables spectral comparison to drug libraries. In addition, Phase II metabolites, namely glucuronides are

detected using true Neutral Loss (NL) scanning and identified by EPI acquisition and spectral matching. The loss of dehydroglucuronic acid with a m/z ratio of 176 is characteristic of all glucuronide metabolites. Chromatographic separation is based on a 2.1 mm ID, 5 micron Gemini column with an acetonitrile, formic acid, and ammonium formate mobile phase gradient ramp optimized for separation of various drugs and metabolites. The method is used to detect drugs in forensic and clinical research samples and was developed to provide greater scope, sensitivity, and selectivity compared to conventional methods of drug detection. The method will help to determine whether or not a drug has been taken/administered even after the parent drug has been completely eliminated from the body of the victim.

LC/MS/MS, Metabolites, Toxicology

K13 Application of Ion Mobility Spectrometry to the Analysis of Gamma-Hydroxybutyrate and Gamma-Hydroxyvalerate in Toxicological Matrices

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After attending this presentation, attendees will learn about a rapid, portable, screening technique for the simultaneous analysis of GHB, GHV, and analogs in urine. The physical extraction of the hydrophilic analytes from urine will be discussed, as will the benefits of ion mobility spectrometry in forensic analyses.

This presentation will impact the forensic community and/or humanity by introducing a physical extraction with ion mobility spectrometry as a rapid, portable screening technique suitable for the detection of GHB, GHV, and analogs in urine.

The predator drug, gamma-hydroxybutyrate (GHB), the lactone precursor (gamma-butyrolactone, GBL), and the diol precursor (1,4-butanediol, BD) continue to present significant analytical challenges to forensic toxicologists and chemists. The five-carbon analog (gamma-hydroxyvalerate, GHV) and the corresponding lactone (gamma-valerolactone, GVL) are emerging as substitutes for GHB, adding further complications.

A rapid and reliable screening test for detection of GHB and GHV would be useful for toxicologists as well as forensic chemists working with solid dose samples. This lab has previously reported a microcrystal test effective for aqueous solutions, but felt the development of a rapid, simple instrumental test effective for screening urine required development. In addition, GHB and GHV are extremely hydroscopic and hydrophilic, negating the possibility of rapid and simple extractions that might be necessary for quick screening. Thus, any successful GHB/GHV screening methodology must either be matrix independent or insensitive or capable of rapid and semi-quantitative extraction from the matrix. The latter issue has been the limiting factor to date.

Ion mobility spectrometry (IMS) was investigated as a method of screening urine for the presence of these drugs and their degradation products. In the present study, a high-performance split/splitless injector and autosampler were utilized to effect a physical separation of GHB and GHV from aqueous matrices (including urine) based on differences in relative volatility. This was achieved by a timed period of solvent evaporation followed by rapid temperature increase and thermal desorption of the residuals. The injection method in effect replaces problematic solvent extraction methods with a physical extraction, an efficient method in the present case considering the hydrophilic nature of GHB. Sample was introduced directly into a detection system

without any chromatography, resulting in rapid analysis times. The negative ion mode showed the greatest sensitivity with detection limits in the low parts-per-million range for GHB and GHV. Since GHB is often delivered in alcoholic beverages, ethanol and acetaldehyde, along with potential interfering compounds methanol, isopropanol, acetone, were also analyzed. None were found to interfere. The thermally-induced ring opening prevented differentiation of GHB and GBL using direct injection/ thermal desorption protocol, but IMS does show promise as a rapid, simple, and affordable screening technique for GHB and related compounds.

Reduced mobilities of GHB, GHV, GBL, GVL, and BD were determined by analysis of vapor generated from neat samples. Resulting K_0 's are shown in Table 1. GHB, GBL, and BD were indistinguishable based on K_0 's and standard IMS alarm variability (standard is ± 50 us in the drift times). Very slight difference in the reduced mobilities of GHB and GBL were noted, consistent with earlier results.

Table 1

Analyte	GHB	GHV	GBL	GVL	BD
Reduced Mobility (K_0)	1.7097	1.6190	1.7105	1.6380	1.7103

To gauge applicability in toxicology, GHB and GHV were dissolved in saturated synthetic urine solutions followed by serial dilutions as described previously. The synthetic urine was found to have no interfering peaks and LOD was estimated to be in the low ppm range by serial dilution methods. Furthermore, GHB and GHV are distinguishable in synthetic urine. Although the urine matrix contributes additional background peaks, the analytical peaks remain discernible.

Ion Mobility Spectrometry, GHB, GHV

K14 Chromatographic and Mass Spectrometric Characteristics of Multiply Derivatized Opiates

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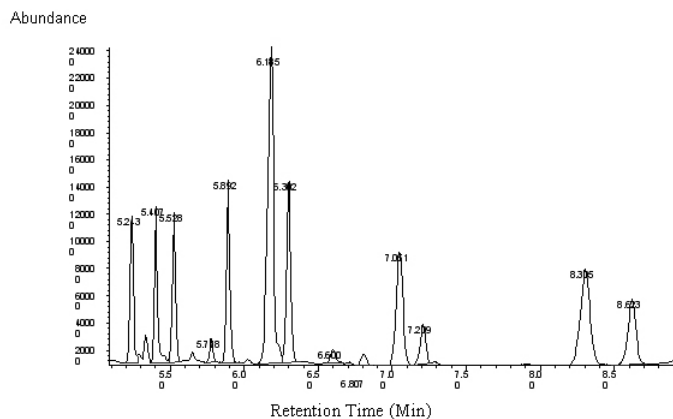
After attending this presentation, attendees will have deeper appreciation on how the analysis of drugs/metabolites in biological media can be facilitated by various chemical derivatization methods.

This presentation will impact the forensic community and/or humanity by illustrating how multiple derivatization approaches can facilitate chromatographic resolution of structurally closely related opiates (see the list below), allowing a single analytical run to analyze all or those that are present. Mass spectrometric characteristics pertinent to quantitative analysis will also be emphasized.

Much attention has been directed to gas chromatography-mass spectrometry (GC-MS) analysis of morphine and codeine. Since other opiates, such as hydrocodone, hydromorphone, oxycodone, and oxymorphone, may interfere with the analysis of morphine and codeine and the analysis of these compounds themselves are also important issues, two double-derivatization approaches utilizing hydroxylamine (HA) and methoxyamine (MA) to first form oxime products with keto-opiates have been reported. The first approach adapted HA, followed by the derivatization with trimethylsilyl (TMS), while the second approach utilized MA, followed by pentafluoropropionyl (PrA) or TMS derivatizations. A review of the literature indicated that studies involving HA were limited, while the MA/PrA studies were (a) unable to chromatographically separate codeine and oxycodone; (b) unable to derivatize the hydroxyl group of oxycodone; and (c) did not include noroxycodone. On the other hand, the MA/TMS studies (a) did not

include oxymorphone and noroxycodone; and (b) intensity cross-contributions between the ions designated for the analytes and their deuterated internal standards are generally very significant; thus, limiting the quantitation capability of this approach.

This study included a comprehensive list of compounds: codeine, morphine, 6-acetylmorphine, hydromorphone, oxymorphone, hydrocodone, oxycodone, and noroxycodone. Three-step derivatization approaches involving various combinations of derivatization groups were explored. Combination of MA/acyl/TMS was found to be most favorable. Merits of this approach include: (a) all functional groups in all analytes were derivatized; (b) the resulting products were chromatographically well resolved (Figure 1); and (c) intensity cross-contribution between the ions designated for these analytes and their respective deuterated internal standards were also found favorable (Table 1). Parallel approaches utilizing HA produced inferior results.



Ret. time	Derivatization product	Ret. time	Derivatization product
5.24	Codeine-TMS	5.40	Hydrocodone-MA
5.78	Oxycodone-MA-TMS	5.89	Codeine-PrA
6.16	Oxycodone-MA-PrA	6.18	Morphine-PrA-TMS
6.30	Hydromorphone-MA-PrA	6.60	6-Acetylmorphine-PrA
6.81	Oxymorphone-MA-PrA-TMS	7.21	Morphine-2PrA
8.62	Noroxycodone-MA-PrA-TMS		

Figure 1. Ion chromatogram of multiply derivatized opiate mixture.

Table 1. Cross-contribution (CC) data of ions (m/z) with potential for designating the analyte and the adapted internal standard (IS)

Derivatization product	Ion designating the analyte/IS and CC (in parentheses)
Codeine-TMS	313 (4.53) / 316 (4.83), 343 (4.66) / 349 (0.10), 371 (0.27) / 377 (0.11)
Hydrocodone-MA	297 (0.084) / 303 (0.00), 298 (0.00) / 304 (0.00), 328 (0.00) / 334 (0.00), 329 (0.00) / 335 (0.00)
Oxycodone-MA-TMS	326 (4.25) / 332 (3.23), 401 (0.00) / 407 (0.03), 416 (0.00) / 422 (0.07), 417 (0.00) / 423 (0.06)
Codeine-PrA	282 (0.31) / 288 (0.01), 298 (0.35) / 304 (0.04), 355 (0.33) / 361 (0.00), 356 (0.44) / 362 (0.00)
Oxycodone-MA-PrA	230 (0.00) / 236 (0.00), 295 (0.00) / 301 (0.00), 343 (0.00) / 349 (0.00), 400 (0.00) / 407 (0.00)
Morphine-PrA-TMS	357 (1.92) / 360 (1.12), 413 (0.32), 416 (1.43)

<u>Derivatization product</u>	<u>Ion designating the analyte/IS and CC (in parentheses)</u>
Hydromorphone-MA-PrA	283 (0.56) / 289 (0.036), 314 (0.50) / 320 (0.004), 315 (2.32) / 321 (0.21), 339 (0.00) / 345 (0.31), 370 (0.12) / 376 (0.009)
6-Acetylmorphine-PrA	215 (4.19) / 218 (1.83), 268 (1.97) / 271 (1.55), 383 (0.17) / 389 (0.00), 384 (0.21) / 390 (0.00)
Oxycodone-MA-PrA-TMS	215 (4.96) / 218 (1.87), 402 (0.94) / 405 (1.40), 403 (1.88) / 406 (0.70), 443 (0.085) / 446 (1.52), 458 (0.059) / 461 (1.64)
Morphine-2PrA	268 (2.02) / 274 (0.04), 324 (0.16) / 330 (0.04), 341 (0.24) / 347 (0.00), 342 (0.63) / 348 (0.00), 397 (0.15) / 403 (0.02)
Noroxycodone-MA-PrA-TMS	427 (0.00) / 430 (0.00), 458 (0.00) / 461 (0.00)

Opiate, Derivatization, Internal Standard

K15 Analysis of Amphetamines in Postmortem Matrices Using In-Matrix Alkylchloroformate Derivatization and Automated HS-SPME Followed by GC-MS

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The goal of this presentation was to evaluate the application Solid Phase Microextraction (SPME) and analysis for amphetamines in various postmortem matrices.

This presentation will impact the forensic community and/or humanity by demonstrating an automated extraction method for postmortem samples.

The extraction process of the sample for forensic toxicological analysis is necessary for the testing of analytes, such as drugs or poisons. A recent method of sample extraction known as SPME offers a number of advantages compared to previous extraction methods. SPME combines several phases of sample preparation (such as extraction, concentration, derivatization, and transfer to the analytical instrument) in one step. This can lead to a great reduction in sample preparation time, as well as solvent usage necessary to complete the sample preparation. Additionally, the application of autosampler provides a fully automated SPME sample preparation process.

Limited knowledge is available in the literature in terms of the application of SPME techniques for postmortem tissue samples (i.e., brain, liver, and kidney) and body fluids other than blood and urine (i.e., vitreous humor, bile, stomach, intestinal fluids, and saliva). These tissue and body fluids are important sources for forensic toxicological analysis; therefore, the development of SPME method for tissue samples is needed. In this study, the application of HS-SPME method for forensic toxicological analysis of postmortem samples was examined.

This study performed the analyses of amphetamines by automated HS-SPME-GC-MS. Amphetamines as a class are commonly abused, and therefore are frequently tested in postmortem toxicology

laboratories. The researchers have adapted the in-matrix alkylchloroformates derivatization method for amphetamine analysis in the blood matrix. Additionally, the application of this method for automated HS-SPME was examined.

The sensitivity of this method as expressed limits of detection was 10 ng/mL for the amphetamines tested in the blood matrix. The precision study indicated the results obtained using this method were reproducible for amphetamine, methamphetamine, and methylenedioxy-methamphetamine. Additionally, the accuracy of the method was within 20% variation of the spiked concentration. In contrast, the precision study showed the results obtained using this method were not reproducible for methylenedioxyamphetamine. Moreover, the accuracy of the method was more than 20% variation of the spiked concentration for methylenedioxyamphetamine in the blood matrix. The underlying causes of these effects need to be investigated in a future study.

The matrix effect study demonstrated that the biological fluid samples tested yielded higher signal responses than those of solid tissue samples. In addition to blood, the study indicated that stomach contents, urine, and vitreous humor were applicable for the SPME method. The matrix effects of the tissue matrices tested interfered with the SPME extraction of amphetamines tested; thus, they were unlikely applicable for the HS-SPME method used in this study.

Amphetamines, Alkylchloroformate, Solid Phase Microextraction

K16 Isotopic Dilution in the Analysis of Cocaine, Cocaethylene, and Benzoylcegonine in Whole Blood: Comparison of the “Traditional” to the “Direct” Application of Deuterated Drug Analogs

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After attending this presentation, attendees will obtain a better understanding of mass spectral analyses incorporating isotopically labeled drug analogs as internal standards. A review of the traditional use of isotopically labeled drug analogs and, more importantly, their use in an expanded analytical role is presented. The attendee will obtain an understanding of Response Factors and Relative Response Factors in quantitative mass spectrometric analyses.

This presentation will impact the forensic community and/or humanity by demonstrating that costs can be greatly reduced, without sacrificing analytical reliability, by lowering the number of GC/MS injections necessary, ultimately resulting in decreased instrument time. Costs associated with analyst's time are also greatly reduced because only four extracts are necessary: (1) a single calibration standard to verify the Relative Response Factor (RRF) and to establish the necessary qualitative criteria (retention times, ion ratios, etc), (2) a positive control, (3) a negative control, and (4) the specimen. This direct analytical approach greatly simplifies analysis of blood samples containing multiple analytes because additional isotopically labeled drug analytes can be added at the beginning of the extraction sequence.

Traditionally, laboratories use isotopically labeled drug analogs as internal standards for quantitating drugs in biological specimens. Calibration curves are constructed by plotting the response ratios, i.e., area abundances of drug-D₀/ area abundances of drug-D_n versus the concentrations of the drug-D₀. For purposes of this study D₀ represents the drug analyte, and D_n refers to the tri-deuterated, isotopically labeled, drug analog.

In the “direct” application of deuterated drug analogs, the concentration of D_o in the specimen is determined directly from the amount of D_n used in the analysis by applying the following relationship:

$$\text{ng/mL } D_o = (\text{Area abundance } D_o / \text{Area abundance } D_n \times \text{nmol } D_n \times 1 \text{ nmol } D_o / 1 \text{ nmol } D_n \times \text{MW } D_o) / \text{mL specimen.}$$

To validate this approach, the Relative Response Factor (RRF) for D_o relative to D_n over the range of expected results is established. The RRF is determined by considering the individual Response Factors (RF) for D_o and for D_n , where RF is defined as the magnitude of some measurable parameter divided by the amount giving rise to that measurement, or $\text{RF-}D_o = \text{area abundance } D_o / \text{nmole-}D_o$, and $\text{RF-}D_n = \text{area abundance } D_n / \text{nmole-}D_n$. The RRF ($\text{RF-}D_o / \text{RF-}D_n$) is determined for each point in the range. Theoretically, an RRF of 1.0 over a given range indicates that the mass spectrometer response to D_o is identical to the response to D_n for that range.

Mathematically, $\text{RRF} = \text{RF-}D_o / \text{RF-}D_n$; or $\text{RRF} = \text{Area } D_o / \text{nmole } D_o$ or $\text{Area } D_o / \text{Area } D_n \times \text{Area } D_n / \text{nmole } D_n \times \text{nmole } D_o / \text{nmole } D_n$ which, on rearrangement results in $(\text{Area } D_o / \text{Area } D_n) = \text{RRF} (\text{nmole } D_o / \text{nmole } D_n)$ and represents a linear relationship in the $(y = mx + b)$ format. By plotting $(\text{Area } D_o / \text{Area } D_n)$ as y ; $(\text{nmole } D_o / \text{nmole } D_n)$ as x ; and setting b to 0, the slope (RRF) is obtained.

This study demonstrated that the RRFs for cocaine, cocaethylene and benzoylecgonine were 1.01, 0.99, and 0.99 respectively over the range of 20 – 2000 ng D_o versus 100 ng D_n with R^2 values greater than 0.99 for each, which indicated that the mass spectrometer response to D_o was the same as the response to D_n over that range and allowed for the D_o concentration in a whole blood specimen to be determined directly from the amount of D_n used in the analysis.

Drug Analyte (Drug- D_o), Deuterated Drug Analog (Drug- D_n), RRF (Relative Response Factor)

K17 Simultaneous Extraction of Pesticides From Human Adipose Tissues and GC/MS Detection

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After attending this presentation, attendees will understand the value of retaining alternative tissues for postmortem toxicological analyses.

This presentation will impact the forensic community and/or humanity by demonstrating the utility of alternative postmortem tissue analysis in determining defensible cause of death. The objective of this presentation is to relate experiences regarding use of adipose tissue, as a supplement to blood and other organs, for the postmortem identification of pesticides.

A modified method is presented¹ for the efficient extraction of pesticides from human adipose tissue. The procedure combines purification, extraction on Extrelut column and GC/MS analysis.

5 g adipose tissue pesticide free homogenate was spiked with 2.8 mcg/g of a mix of pesticides (73 ng/mL Dichlorvos, Fludioxonil, Methiocarb, Methomil, Chlorpyrifos, Thiamethoxam, Tebufenpyrad, Tebuconazol, Quinoxifen, Pyrimethanil, Penconazol). The mixture was vortexed for 15 seconds and 10 g of anhydrous sodium sulphate and 0.5 g of tartaric acid added.

The homogenate was extracted three times with petroleum ether, followed by evaporation of the ether layer at room temperature under N_2 . The residue was reconstituted in 20 mL of petroleum ether, filtered, and extracted with 5 mL of acetonitrile saturated with petroleum ether. 100 mL of a 5% NaCl aqueous solution was added to the acetonitrile/ether phase and extracted with an additional 10 mL of petroleum ether. The extract was again evaporated at room temperature under N_2 .

5.5 g of florisil was activated (120°C, 30 min), and placed in an Extrelut column (Merck). The extract was reconstituted with 2.5 mL of petroleum ether and added to the column. The column was then eluted with 50:50 ethyl ether/petroleum ether and the eluate evaporated at room temperature under N_2 . The residue was then reconstituted and injected into a GC/MS-EI operating in full scan mode.

This extraction procedure for pesticides in human adipose tissue was evaluated on the basis of accuracy, reproducibility, and chromatographic profile. The method is simple and rapid and produces relatively clean extracts, suitable for gas chromatography/mass spectrometry full scan EI analysis. The acidic purification/solid-phase extraction provided best compromise between recovery and chromatographic profile.

References:

¹ Locani O.L.; Perkins de Piacentino A.M.; Ginesin L.M., Mangas L., Matrices Alternativas: Tejido Adiposo una Matriz de Eleccion, Cuadernos de Medicina Forense, 2005: 2 (3): 29-40

Adipose Tissue, Alternative Tissue, Pesticide

K18 Detection of Biomarkers of Explosives

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After attending this presentation, attendees will become familiar with an approach to detect biomarkers of explosives using screening and low level detection techniques.

This presentation will impact the forensic community and/or humanity by providing novel screening methods that will extend the detection time and concentration ranges of metabolized explosives.

Detecting explosive biomarkers in human biological fluids can be useful in identifying individuals who have either handled or been exposed to explosive compounds. In order to fully implement such detection, methods ranging from screening to trace level detection of metabolites are needed. This presentation will discuss two such techniques applied to volatile biomarkers of explosives.

Explosive compounds may enter the body via inhalation or skin absorption and undergo metabolism. Once the explosive compounds are metabolized, the metabolites may be present in blood and urine. The volatility of these explosives and their metabolites may provide alternative means for detecting them in biological fluids. Finding unique metabolites also referred to as biomarkers, in biological samples will give forensic toxicologists a valuable investigative tool that can assist in identifying people who have handled explosives. The concentration of these biomarkers in the body may be too low to detect using standard analytical techniques. For trace level metabolites, a preconcentration technique such as purge and trap gas chromatography/mass spectrometry (PT GC/MS) is ideal for detecting volatile metabolites in biological matrices. Another method, ion mobility spectrometry (IMS), is a rapid and sensitive screening method with low detection limits. IMS is widely used for the detection of trace explosive compounds; however, minimal research has been reported using direct headspace samples of explosives with IMS. The present work employed using PT GC/MS and IMS as screening methods for the detection of volatile explosives metabolites in headspace. A loop and a trap method for the PT GC/MS were used for this analysis. The samples were incubated at body

temperature, thirty-seven degrees, for twenty minutes prior to purging. The ability to detect explosives metabolites in biological matrices is time limited because the body metabolizes substances at various rates. Having the capability to preconcentrate using PT GC/MS gives a wider range of time and concentrations to analyze trace metabolites in real biological samples. The advantage of detecting low concentrations with IMS will assist in rapid screening of explosives metabolites in headspace. In the future, this research may aid in the development in a method which would detect explosives metabolites in breath.

Methods for detecting explosives metabolites in headspace of biological matrices can be useful to the investigation of bombers and bomb-makers. This study primarily focuses on TNT and its metabolites, 2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene and dinitrotoluene. Other explosives will also be discussed in this presentation. This information will present headspace data obtained in urine and blood by PT GC/MS and IMS.

IMS, PT GC/MS, Explosives Metabolites

K19 Extraction and Analysis of Warfarin From Whole Blood Using a Long Chain SPE Sorbent

Albert A. Elian, MS, Massachusetts State Police Crime Laboratory, 59 Horsepond Road, Sudbury, MA 01776; and Jeffery Hackett, MSc*, Center for Forensic Sciences, 100 Elizabeth Blackwell Street, Syracuse, NY 13210

The goal of this presentation is to present information on a solid phase extraction method that will improve on existing procedures for the analysis of warfarin in postmortem blood samples.

This presentation will impact the forensic community and/or humanity by improving the analysis of this drug in post mortem samples by utilizing a more efficient extraction system i.e., a long chain SPE sorbent in conjunction with both liquid and gas chromatographic systems.

Warfarin (Coumadin) is a popular pharmaceutical used as a blood-thinning agent. In therapeutic use, blood levels range from 1000 ng to 3100 ng per mL has been reported.¹ Several methods have been used for the analysis of this drug using liquid-liquid extraction.^{2,3} This project was developed in order to study this drug at low levels in post mortem samples using a novel (C₃₀) solid phase sorbent.

In this method, Warfarin and the internal standard (p-chlorowarfarin (100 ng)) were spiked into whole blood samples (1mL) over a concentration range 0 through to 200 ng per mL. The samples were treated with an aqueous phosphate buffer (9 mL) and the drugs extracted onto a C₃₀ SPE columns (200 mg). The columns were washed with the phosphate buffer and hexane (1x 3 mL each) and eluted with 14% methanol acid in ethyl acetate (2x 3mL). The eluents were collected and evaporated for further chromatographic analysis. Using GC-MS, the samples were derivatized prior to analysis using BSTFA, for analysis with LC-PDA the samples were reconstituted in DI water.

GC-MS separation was carried out using an Agilent Technologies 6890 GC coupled to a 5975 MSD for SIM analysis. HPLC analysis was carried isocratically out using both PDA and Fluorescence detection.

From this method LOQ's of 25 ng per mL of sample is easily achievable by either chromatographic system. By using GC-MS (SIM) in EI mode, 10 ng per mL of sample can be detected.

Examples of chromatograms and calibration curves are presented to show the simplicity and efficiency of this methodology.

References:

¹ C.Winek *et al*, Forensic Sci. Int'l 122 (2001) 107-123

² Locatelli *et al*, J.Chrom.B., 818 (2005) 191-8

³ Naidong *et al.*, J.Pharm.Biomed. Anal. 25 (2001) 219-29

Warfarin, SPE, Toxicology

K20 Stability of Exogenous GHB in Antemortem Blood and Urine Under Various Temperature and Storage Conditions

Albert A. Elian, MS*, Massachusetts State Police Crime Laboratory, 59 Horse Pond Road, Sudbury, MA 01776

After attending this presentation, attendees will learn how storage conditions will effect GHB concentration in blood and urine.

This presentation will impact the forensic community and/or humanity by demonstrating the effect of long storage on GHB levels in blood and urine.

The stability of exogenous GHB in three blood and three urine samples under a variety of storage conditions; room temperature, 4°C and -20°C, was evaluated over a period of six months. GHB concentration increased the most at room temperature, with almost no change at the lower temperature.

Gamma-hydroxybutyric acid (GHB) is an endogenous substance found in the body. This central nervous system depressant, which was first synthesized in the 1960s, has been used for induction of anesthesia, treatment of narcolepsy, and for alcohol and opiates withdrawal. Recently, GHB has been used illicitly by bodybuilders to increase the release of growth hormone, ravers attendees for its euphoric, sedation and muscle relaxation after ecstasy use, and victims of drug-facilitated sexual assault (DFSA) [8-10].

Due to the increased demands on forensic toxicologists to analyze GHB in cases such as DFSA and operating motor vehicles under the influence, there are often variable time intervals between collection of the specimen and analysis. A literature review has revealed no stability study on antemortem blood or urine exogenous GHB levels. However, one study reported the effect of storage on endogenous GHB antemortem urine levels, and another study investigated the effect of storage conditions on GHB-free and spiked urine antemortem concentration.

Quantitation of GHB was achieved by liquid-liquid extraction, followed by concentration of the extracts and derivatization with BSTFA. Analysis was performed on an Agilent 6890 gas chromatograph interfaced with an Agilent 5975 mass selective detector. A 12m x 0.25mm (internal diameter), 0.25mm (film thickness), HP-1MS column (100% polydimethylsiloxane) was used with helium as the carrier gas at a flow rate of 2.0 mL/min. An Agilent 7683 automatic sampler was used for injection into the gas chromatograph. The splitless injection mode was used with the valve closed for 0.25 min, and 2ml samples being injected. The operating conditions for the analyses were injection port, 280°C; the detector, 300°C; initial oven temperature, 60°C for 2 min increased at 30°C/min to 300°C, holding for 1 min. The mass spectrometer was operated in the SIM mode. The ions selected for monitoring were chosen from full scan mass spectral analyses of the analytes that gave minimum interference. The following ions were monitored: GHB: m/z 233,234,235 and GHB-d₆: m/z 239,240,241.

Three actual blood (20, 50, and 75 mg/L) were submitted to the laboratory in test tubes containing sodium fluoride. Three actual urine samples (33, 108, and 220 mg/L) were submitted in plastic jars with no preservative added. The samples were chosen, from casework, to cover a wide range of concentrations. The specimens were analyzed at the time of arrival in the laboratory and then divided into three sets as described above.

For the blood stored at -20°C there was an increase in GHB concentration of 1-12%, at 4°C 3.4-16%, and 20°C 9.6-28% (Fig. 1-3). For the urine stored at -20°C there was an increase in GHB concentration of 1-15%, at 4°C 1-27%, and at 20°C 3.6-44% (Fig. 4-6), with the highest increase in GHB concentration in the lower concentrations (Fig. 1 and 4). This could be attributed to the fact that a small increase in the GHB level would be enough to significantly change to the measured level.

Storage, Gamma-Hydroxybutyric Acid (GHB), Exogenous

K21 Evaluation of the Immunalysis® Fentanyl ELISA Assay for Use in Screening Postmortem Blood

Denice M. Teem, BS*, Daniel S. Isenschmid, PhD, Bradford R. Hepler, PhD, and Carl J. Schmidt, MD, Wayne County Medical Examiner's Office, 1300 East Warren Avenue, Detroit, MI 48207

After attending this presentation, attendees will be aware of a rapid ELISA screening test for fentanyl in postmortem blood that is sensitive, specific, and efficient.

This presentation will impact the forensic community and/or humanity by providing the toxicologist with data to aid in the selection of a reliable screening assay for fentanyl in postmortem blood.

Since 1999, the Wayne County Medical Examiner's Office (WCMEO) has routinely looked for fentanyl in its GC/MS screen (LOD, 5 ng/mL). The incidence of cases in which fentanyl was identified was 6 (1999), 3 (2000), 7 (2001), 12 (2002), 20 (2003) and 29 (2004). These gradual increases were largely due to increased use and abuse of fentanyl patches and lollipops. Fentanyl confirmation and quantitation had been performed by a reference laboratory until May 2005 when the WCMEO developed a GC/MS-SIM confirmation method (LOD, 1ng/mL). Due to an outbreak of fentanyl-laced cocaine and heroin in the last 3 months of 2005, the incidence of fentanyl increased to 63 in 2005 and 132 for the first six months of 2006. Due to the surge in fentanyl-related cases, it was necessary to add an immunoassay to allow the laboratory to rapidly identify potential fentanyl-related cases and to expand its fentanyl screening protocol to all autopsied cases.

The Immunalysis® ELISA fentanyl assay was evaluated for use in screening postmortem blood using Tecan® equipment. Pipetting was performed on Miniprep 75 using a 1:10 specimen dilution without any sample pretreatment. Plates were washed with a Columbus II plate washer and read using a Spectra II plate reader.

Pooled postmortem negative blood (as determined by ELISA and GC/MS) was used as a negative calibrator. A cut-off calibrator (2 ng/mL) and controls (1 ng/mL and 4 ng/mL) were prepared in-house by fortifying blood from the negative blood pool.

The within-run precision and linearity around the cutoff of the fentanyl assay was determined by assaying negative, 1, 2 and 4 ng/mL calibrators and controls (N=16) interspersed throughout a single plate. The assay demonstrated good precision and excellent separation as summarized in Table 1.

Table 1

Concentration	%CV	Average A/Ao	SD
Negative	5.27	97.81	5.15
1 ng/mL (low control)	6.73	47.04	3.16
2 ng/mL (cutoff)	7.64	26.42	2.02
4 ng/mL (high control)	11.72	14.84	1.74

Between-run precision was assessed by using the A/Ao obtained for the low and high controls that were assayed three and four times, respectively, in each ELISA batch. For the high control the CV was 13.2% (N=24). The low control had a CV of 13.3% (N=18). These CV's appeared to reflect the variation in ELISA assays and were not a result of pipetting imprecision as the Miniprep 75 demonstrated a CV of only 0.11% for the pipetting of the sample and diluent (N=64). ELISA assays typically demonstrated higher CV's than traditional immunoassays, however by calibrating using the mean of duplicate negative and cutoff calibrators, and due to the excellent separation around the cutoff calibrator, there were no failed controls on any batch ran.

Sensitivity, specificity, and efficiency were evaluated comparing the ELISA and GC/MS results with 314 blood specimens. These included a series of known positive samples and a series of sequential

blood specimens analyzed in sequence as per routine casework. There were 225 true negatives and 88 true positives. The single false positive by ELISA was readily explained by the 1.9 ng/mL GC/MS concentration that was just below the cutoff. There were no false negatives. This resulted in excellent sensitivity (98.9%), specificity (99.6%), and efficiency (99.7%).

Fentanyl, ELISA, Method Evaluation

K22 Capillary Electrophoresis/Electro-Spray Ionization/Time-of-Flight Mass Spectrometry of Low Dose Benzodiazepines

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The goal of this presentation is to determine the usefulness of capillary electrophoresis electro-spray ionization time-of-flight mass spectrometry (CE-ESI-TOF-MS) for the detection of low dose benzodiazepines.

This presentation will impact the forensic community and/or humanity by providing a new approach to accurately and consistently determine the presence of benzodiazepines at low concentrations. This technique can then be applied to cases where drug facilitated sexual assault is suspected.

Besides being used for therapeutic purposes benzodiazepines are commonly abused at parties, night clubs, and raves because of their ability to cause euphoria and a drunk-like high. Common low dose benzodiazepines include alprazolam, clonazepam, lorazepam, and triazolam. When benzodiazepines are taken in the presence of alcohol, the user experiences heightened effects as well as amnesia and unconsciousness. In such instances the drug is often used as a tool in drug facilitated sexual assault and can be present in such low concentration that it is often difficult to detect. In cases of sexual assault, the type, concentration, and number of drugs taken can aid in the investigation. However, there are few methods capable of fully determining this information.

Recently, capillary electrophoresis has been proposed as an alternative to GC/MS for toxicological analysis, especially when coupled to electrospray mass spectrometry (ESI-MS). CE has several advantages which make it an ideal method to couple with ESI-MS. It has high efficiency, minimal sample requirements, and short analysis time. MS is an analytical technique that can reveal specific, characteristic, and structurally related information about a compound. The analytes must be present in the vapor phase, and this condition is obtained via electrospray analysis.

The present work was performed on an Agilent CE-ESI-TOF-MS which utilizes a sheath flow interface to spray a minimal and regulated amount of the eluted CE sample into the TOF. The TOF provides several advantages when used in combination with CE. The system is very fast compared to trap systems or quadrupoles and has a 3ppm or less mass resolution, allowing extremely accurate empirical formula determination based on high resolution mass determination. The system identifies drugs based on four operational parameters: absolute mass, prediction of related absolute isotopic mass abundances, in-source collisional dissociation, and electrophoretic mobility. The high separation efficiency of CE combined with the high sensitivity and information content of MS makes this instrument a powerful tool for screening and confirmation of drugs. These characteristics make ESI-TOF one of the more suitable mass spectrometric detection methods for CE.

Selected benzodiazepines were analyzed using this system, and extracted ion analysis was performed with high selectivity by using the exact masses of the protonated molecular ions. This capability greatly reduced background noise and improved detection. The effect of buffer

pH, concentration, and spray parameters were also examined. The capillary column used had a 75 micron internal diameter and a length of 95mm. The polyimide coating was removed from the end of the capillary and a blunt tip was cut in the fused silica with a sapphire scribe. This was crucial when using the CE-MS to obtain a perfect and precise spray while eliminating adsorption of the sample on the outside of the capillary. The running buffer used was 20mM formic acid at a pH of 2.7. At this low pH the drugs were cationic, and, although a low electro-osmotic flow (EOF) resulted, electrophoretic mobility and induced flow resulting from the sheath liquid during analysis enabled overall run times of under 8 minutes. The results demonstrate CE-ESI-TOF to be a rapid and highly specific detection method for benzodiazepines.

Capillary Electrophoresis, Time-of-Flight Mass Spectrometry, Benzodiazepines

K23 Cases of Insulin Poisoning

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After attending this presentation, attendees will be briefed on cases of poisoning due to exogenous insulin administration and the measurement of insulin in forensic specimens.

This presentation will impact the forensic community and/or humanity by demonstrating the identification of insulin and C-peptide in forensic specimens.

Hypoglycemia caused by deliberate or inadvertent administration of insulin is a potentially lethal disorder. Self-induced hypoglycemia by clandestine use of insulin was reported in 1982 by a nurse seemingly with the sole purpose of attracting attention and sympathy. Since that report, similar cases have been described in diabetics as well as non-diabetics. Although it is clear that insulin induced hypoglycemia can cause death, in most cases of death occurring within 24 hours of proven hypoglycemia, classic autopsy procedures reveal no unique pathophysiologic abnormalities. After B-cell stimulation by carbohydrate intake, insulin and C-peptide are secreted in 1:1 molar ratio. A large portion of insulin is cleared by the liver, while the C-peptide which is primarily cleared by the kidney has a lower metabolic clearance. In normal physiology, the molar ratio of insulin to C-peptide in endogenous secretion should be less than one. Hypoglycemia caused by exogenous insulin is associated with high serum levels of insulin and low serum levels of C-peptide. Thus, the ratio of insulin to C-peptide should be greater than one. The following four cases were recorded as possible overdose of insulin.

Case Study 1: A 53-year-old white female was found unresponsive in a motel room with numerous syringes lying around the body along with Humulin. An alleged suicide note was recovered by the police. Medical records indicated that the deceased was an insulin dependant diabetic with cardiac history. Police reports also indicated that the decedent's girl friend reported that the decedent was going to commit suicide with an overdose of insulin if she broke off their relationship.

Case Study 2: A 20-year-old black female living with her male companion made statements regarding suicide on several occasions. The male companion who was a diabetic reportedly moved out with his supply of insulin and syringes and did not leave any behind. He called the police when he was unable to contact her, fearing she had committed suicide. Police found a secured house. There was no evidence of injury, but an empty insulin bottle was found on the scene. Autopsy revealed a gravid uterus with a normally developed fetus.

Case Study 3: A 34-year-old white female was discovered deceased in her motor vehicle. Inside the vehicle were found insulin packages and syringes, including some empty insulin bottles. A hand

written note to her psychiatrist was also found stating "forgive me Dr." According to the spouse, the decedent made prior suicide attempts; one of them with overdose of insulin.

Case Study 4: A 38-year-old white male with morbid obesity was found deceased in his residence. The decedent had a history of diabetes and had accidentally sustained a gun shot wound several years ago. The projectile was still believed to be in his back. The decedent was depressed and told his relatives that if he continued to not feel well he was going to kill himself with an over dose of insulin.

Insulin and C-peptide results are shown in the table below.

Case Number	Insulin uIU/mL	C-Peptide ng/L	Insulin/C-Peptide Ratio	Diagnosis
Case 1	4.3	0.3	0.3	Cardiovascular disease
Case 2	88.5	0.1	18.7	Suicide Insulin Overdose
Case 3	524	0.1	110.6	Insulin Overdose
Case 4	5.0	0.1	1.1	Cardiomegaly

Specimens were analyzed for Insulin and C-Peptide by RIA, using commercially available reagent kits from Diagnostic Systems Laboratories (Webster, TX). Since post-mortem specimens were highly hemolyzed, the protocols were modified to include standard addition recovery and serial dilution for each specimen analyzed. Further validations included comparison between duplicate results of insulin and C-peptide on the same specimens analyzed by the authors' laboratory and Mayo Clinic Laboratories; correlations by Pearsons r were 0.82 and 0.99, respectively. The ratio cutoff was validated from clinical specimens. For example, a specimen was obtained from a patient suspected of insulinoma and analyzed for insulin and c-peptide; insulin concentration was 18.1 uIU/mL, and C-peptide was 19.7 ng/mL, providing a molar ratio of 0.02. Eleven specimens obtained from diabetic patients who are on insulin therapy were also analyzed for insulin and C-peptide. All of them had C-peptide levels approaching the assay's detection limit, and insulin:C-peptide ratios were 1 or less. Typical units for insulin and C-peptide levels are as number of moles. The ratio was calculated with the formula Insulin:C-peptide Molar Ratio = (Insulin uIU/mL ÷ C-peptide ng/mL)(0.0211). The ratios obtained were consistent with the literature. Moreover, the ratios from appropriate medical use of insulin can be distinguished from insulin overdose. These results confirm the use of "Insulin/ C-peptide" ratio in suspected insulin overdose, using commercial RIAs.

Insulin Poisoning, Syringes, Suicide

K24 Effect of Torso Dart Position and Cocaine Intoxication on Taser® Induction of Ventricular Fibrillation

Patrick J. Tchou, MD, Dhanunjaya Lakkireddy, MD, and Donald Wallick, PhD, Cleveland Clinic Foundation, 9500 Euclid Avenue, Cleveland, OH 44195*

After attending this presentation, attendees will learn about torso dart positions as they relate to the propensity to induce ventricular fibrillation (VF) by neuromuscular stun guns as well as the effects of cocaine on VF induction thresholds by stun guns.

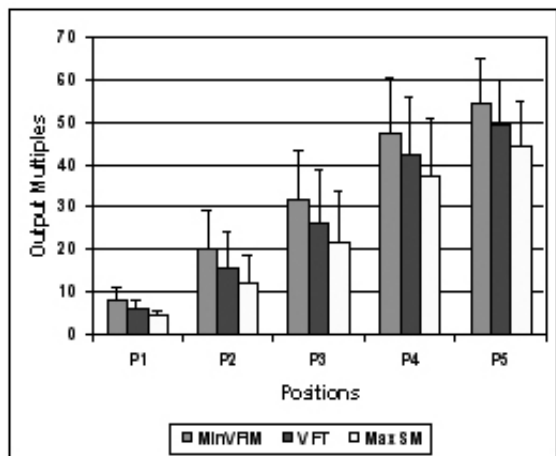
This presentation will impact the forensic community and/or humanity by assessing the likelihood that stun guns contribute to induction of ventricular fibrillation in such subjects.

Neuromuscular stun guns are increasingly used by law enforcement to restrain uncooperative and combative subjects being taken into custody. Multiple deaths have been reportedly associated with the use of stun guns. This study aimed to assess the threshold for ventricular

fibrillation (VF) induction using the Taser® X26 waveform with darts positioned at various common torso locations in an anesthetized pig model. The effect of cocaine on the VF induction thresholds was also investigated.

Thirteen pigs (34±7 kg) were utilized in the initial study to assess dart locations on VF induction thresholds. Dart positions on the torso were as follows: 1) Sternal notch (SN) to cardiac apex 2) SN to supraumbilical area 3) SN to infraumbilical area 4) side to side on the chest 5) superior to inferior region of the dorsum. Increased outputs of the Taser® X26 waveform was delivered by increasing the capacitance of the stored charge in a custom built device. VF thresholds were determined by a stepwise increasing output until VF was induced by a multiple of the baseline capacitance. VF thresholds were also measured in five pigs after infusion of cocaine at 8 mg/kg over 30 minutes.

Results are shown in the following figure.



MinVFIM = minimum capacitance multiple inducing VF
 Max SM = maximum multiple not inducing VF on 3 consecutive applications
 VFT (VF threshold) = average of MinVFIM and MaxSM
 P1-P5 = Positions 1 through 5

Cocaine consistently increased MinVFIM, MaxSM and VFT at all positions by 50% to 200%. Intracardiac electrograms demonstrated that VF induction was related to rapid ventricular capture by the Taser® pulses.

Conclusions: NMI output equivalent to standard Taser® X26 did not induce VF in any pig. Position of the darts significantly affects propensity for induction of VF being most sensitive in the precordial position. Cocaine increased VFT probably through its sodium channel blocking properties.

Neuromuscular Stun Guns, Ventricular Fibrillation, Cocaine

K25 Enforcement of DUID Laws in European Nations — Sweden’s Zero Limit Blood Law and Case Examples

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After attending this presentation, attendees will obtain an overview of the way drug-impaired driving is dealt with in European nations. The main focus will be on new legislation introduced in Sweden where zero-concentration limits in blood are enforced for both licit and illicit drugs, if these are classified as controlled substances. The forensic community in North America will learn the effectiveness of so-called zero tolerance legislation as a way to simplify the prosecution of DUID offenders and hopefully improve traffic safety.

This presentation will impact the forensic community and/or humanity by demonstrating the effectiveness of so-called zero-tolerance laws for driving under the influence of drugs (DUID) as a new countermeasure to improve traffic safety. Since the introduction of a zero-limit DUID law in Sweden the number of people apprehended by the police for this traffic crime has increased 10-fold. In the vast majority (85%) of such cases one or more banned substances are detected in blood samples and the prosecution and conviction of DUID has become much more streamlined.

Legislation pertaining to driving under the influence of drugs (DUID) has evolved from the pre-existing alcohol-impaired driving laws, which have a long history. The statutory limits of blood-alcohol concentration (BAC) for driving have decreased successively from 0.15 g/100 mL to 0.1 g/100 mL and are presently set at 0.08 g/100 mL in UK, USA, and Canada. This contrasts with the corresponding threshold BAC limits in most European nations of 0.05 g/100 mL and 0.02 g/100 mL in Norway and Sweden. The notion that DUI laws are science-based is clearly a myth as evidenced by this wide range of punishable concentrations - reflecting, of course, politics, rather than traffic safety research. The success of concentration *per se* laws as evidence of alcohol-impaired driving has prompted similar discussions for DUID legislation. Such a legal framework shifts the focus of the prosecution case away from evidence of driver impairment towards the concentration of a banned substance determined in a specimen of blood obtained from the suspect. The actual driving, the behavior of the suspect when questioned, and performance of skilled tasks, become supporting evidence in the prosecution case.

Studies aimed at finding a quantitative relationship between the concentrations of illicit drugs in blood and degree of diminished performance and impairment of the individual are few and results are often equivocal. There are many ethical constraints about the design of such studies including selection of subjects, the dose of drug administered and the suitability of the performance tasks. This stems, at least in part, from the complex nature of drug-related impairment and the time-lag between the blood-drug concentration and the onset of drug-related effects as well as after-effects or rebound phenomena and withdrawal. The situation is complicated still further by habituation to drugs, especially those with long half-lives, which tend to accumulate in blood after repetitive use and leads to the development of physiological tolerance. Moreover, many prescription drugs impair a person’s ability to drive safely and some have pharmacologically active metabolites that exert their own effects on a person’s performance and behavior. Effective DUID legislation cannot ignore the widespread use and abuse of medicinal drugs; anti-anxiety agents, sedatives, hypnotics and pain-killers and the associated performance decrement these cause.

The impetus to consider seriously a zero-limit blood law for drugs other than alcohol arose from media attention given to several high profile DUID cases. A female driver (30 y) was stopped by the police during a routine traffic control. A preliminary breath-alcohol test was negative but one of the police officers noticed that the woman’s eyes were bloodshot and that pupils were dilated. This raised a suspicion of DUID and a blood sample was requested for toxicological analysis. Otherwise the suspect did not show any marked signs and symptoms of drug influence and she was not examined by a physician nor were field-sobriety tests performed. The toxicology report showed a high concentration of amphetamine (3.4 mg/L) as well as phenmetrazine (0.2 mg/L), both widely abused central stimulants in Sweden. The woman was eventually prosecuted for DUID based on the toxicology report and opinions from several expert witnesses about the effects of such high levels of amphetamine on a person’s ability to drive safely. However, the woman was acquitted in both the lower court and the appeal court because of the lack of well-documented clinical evidence of impairment and the fact that a traffic violation had not been committed. According to the court there was no compelling evidence to prove the suspect was “under the influence” of a central stimulant and posed a danger to traffic safety.

Other examples of widely divergent results between clinical assessment of impairment and the toxicology findings helped to spark the debate about considering zero-concentration limits in blood for drugs other than alcohol. In one notable case a 34-year-old woman was found to be slightly under the influence of a stimulant or depressant drug according to a clinical examination by a forensic physician. The forensic toxicology report verified the presence of several scheduled drugs, both licit and illicit, in a blood sample; amphetamine (0.03 mg/L), phenmetrazine (0.1 mg/L), THC (0.001 mg/L), morphine (0.08 mg/L), codeine (0.02 mg/L) and very high concentrations of diazepam (3.6 mg/L) and its metabolite nordiazepam (7.8 mg/L). Analysis of urine showed high concentrations (>1 mg/L) of free-morphine, free-codeine and 6-acetyl morphine, which verifies the woman had also used heroin.

Poly-drug abuse is the norm in Sweden among DUID offenders. Since the introduction of the zero-concentration limit law for scheduled drugs in blood of drivers in 1999, the number of DUID cases submitted for toxicological analysis has increased more than 10-fold. In about 85% of these cases one or more banned substance is verified present in the blood specimen. The zero-limit law has stimulated police activity in apprehending DUID suspects, which has led to a substantial increase in the workload for the forensic toxicology laboratory. The analytical routines for dealing with DUID cases have been modified so that after an initial screening analysis of blood or urine by immunoassay methods (EMIT/CEDIA), only a single illicit substance is subjected to a quantitative analysis by substantive methods, such as GC-MS or LC-MS. The punishment for DUID in Sweden is the same regardless of how many illicit drugs are verified present in a blood specimen. The introduction of so-called zero-tolerance or LOQ laws furnishes a robust and pragmatic way to enforce DUID legislation, and this simplifies considerably the evidence required for a successful prosecution. However, such laws have done nothing to solve the problem of DUID because recidivism in these traffic delinquents exceeds 50% over a 4-year period.

Drugs, Driving, DUID

K26 “That’s the Night That the Lights Went Out in Ventura” (A DUID Soma / Methamphetamine Case Study)

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After attending this presentation, the participant will receive insight into the events surrounding one of the most prominent “driving under the influence of drugs” cases adjudicated in Ventura County.

This presentation will impact the forensic community and/or humanity by illustrating the difficult challenges and decisions made by the toxicologists; investigators and prosecutors associated with drugged driving collision fatality cases. The detailed Case Study model format and its examination serve as a vehicle to share knowledge and promote discussion in this constantly evolving arena.

At 6:50 p.m. on August 12, 1998, the lights at the Telephone and Hill intersection near the Government Center in Ventura, California were inoperable. Each car was proceeding by treating it as a four-way stop, as is required by law. The first driver, a 28-year-old female senior Deputy, was preparing to turn left on Hill Street onto Telephone heading east. The second driver was in a pick-up truck on Telephone heading west traveling work at UPS. Traffic in the lanes was backed up as people were abiding by the inoperable signal. The second driver approached the intersection at a minimum speed of 56 miles per hour, made a late lane change into the right turn lane of Telephone road, and proceeded straight through the intersection crashing into the car being driven by the first driver. The impact was tremendous and the first driver probably died instantaneously. None of the law enforcement personnel noted any

symptomologies. One even gave the opinion that the second driver was not under the influence of alcohol or drugs.

The second driver admitted only to having taken Claritan and Sudafed. She claimed Soma had been administered two days earlier. At 8:50 p.m. a urine sample was obtained and found to be positive for methamphetamine and Soma. At 9:10, blood was drawn from the second driver, which tested negative for the presence of alcohol but positive for methamphetamine, and Soma. The methamphetamine level was quantified to be at 0.12 milligrams per liter. The Soma level was quantified to be at 0.58 milligrams per liter.

The second driver had been a long-time methamphetamine user. In 1984, she possessed five pounds of methamphetamine to be delivered for sale and pled guilty in Federal Court on that case in 1988. She had tested positive for methamphetamine twice while on probation.

Six separate experts were consulted while preparing for trial in this case. Opinions varied on levels of impairment and the ability to prove a case beyond a reasonable doubt with these facts. The various opinions and their impact on the case will be discussed in the presentation of this case study.

Drugged Driving, Driving Impairment, Under the Influence

K27 Case Study: DUI With Multiple Prescription Drugs

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After attending this presentation, attendees will have been exposed to a case study involving drug impaired driving in which the toxicology results are bolstered by a video of the subject.

This presentation will impact the forensic community and/or humanity by demonstrating some of the impairing effects of Central Nervous System (CNS) depressant drugs and give the audience a better understanding of the physical effects of these drugs.

This case study involves a 39-year-old white male who is involved in a collision where he subsequently fled the scene. Eye witnesses were able to identify him to police and he was arrested at his home a short time later. The police in-car video shows a subject who is obviously under the influence of (CNS) depressants. After a breath alcohol reading of 0.00%, urine was obtained for toxicological analysis. This analysis revealed the presence of diazepam, nordiazepam, temazepam, alprazolam, hydrocodone, acetaminophen, dihydrocodeine, cyclobenzaprine, carisoprodol, and meprobamate.

With exception of acetaminophen, all of the drugs identified are prescription medications (or metabolites) that have CNS depressant actions. Diazepam is a benzodiazepine which is utilized clinically as an anxiolytic, anti-convulsant, sedative, and muscle relaxant. Nordiazepam and temazepam are active metabolites of diazepam which are also used clinically as sedative-hypnotics. Alprazolam is used primarily as an anxiolytic and to treat certain conditions such as agoraphobia and panic disorders. Hydrocodone is a semisynthetic derivative of codeine that is utilized as an analgesic and is often found in combination with acetaminophen. Dihydrocodeine is an active metabolite of hydrocodone that is also utilized clinically as an analgesic. Carisoprodol is used primarily as a centrally acting muscle relaxant with meprobamate being its primary metabolite. Meprobamate is also utilized clinically as a sedative, anxiolytic, and muscle relaxant. Cyclobenzaprine is a tricyclic compound that is structurally similar to amitriptyline but is utilized as a centrally acting muscle relaxant. Some of the more obvious effects of these CNS depressant drugs such as slurred speech, drowsiness, dazed appearance, diminished ability to concentrate or multi-task, and confusion are demonstrated on the video. Additionally, cyclobenzaprine is known to have some anti-histaminic activity which can result in dry mouth, which is also demonstrated on the video.

Drug Impaired Driving, CNS Depressants, Urine

K28 Driving Under the Influence (DUI) in Southern Ohio — Drug Demographics for the Drugs Encountered in DUI Case Work

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After attending this presentation, attendees will become aware of the drug demographics seen in DUI cases analyzed in a regional crime laboratory in Ohio. The region covers a radius of approximately 75 miles around the city of Dayton. This presentation will be an overview of the most commonly encountered drugs in DUI cases analyzed at the MVRCL. Drugs that were encountered in 817 DUI cases during 2005 will be reviewed. Case examples will be used and quantitative values in blood will be listed when available.

This presentation will impact the forensic community and/or humanity by making data available as to commonly encountered drugs in a specific region of Ohio to be used by other labs analyzing DUI cases in making changes to screening protocol or changes to the testing approach used in detecting these drugs. Finally, the top thirteen drug classes will be reviewed in detail as well as mention made of Ohio's new per se law outlining per se levels for marijuana, marijuana metabolite, cocaine, cocaine metabolite, heroin, 6-monoacetylmorphine, amphetamine, methamphetamine, lysergic acid diethyl amide, and phencyclidine in blood, serum plasma and urine. Mention will also be made as to how the drugs chosen in this law may bias some laboratories' DUI protocol.

Methods: DUI cases are first subject to quantitative ethanol analysis by headspace gas chromatography. Depending upon the ethanol result and the case history, analysis may stop or continue for drug analysis. Analysis proceeds with enzyme linked immunosorbent assays (ELISA) for the following drugs or drug classes with cut-offs in blood and urine listed (ng/mL): amphetamine (50), barbiturates (500), benzodiazepines (10), cannabinoids (20), carisoprodol (1000), cocaine metabolite (100), methamphetamine (50), and opiates (25). Any positive ELISA results are subject to confirmation by gas chromatography with mass spectral, flame ionization, nitrogen phosphorus, or electron capture detection. If there are no positive ELISA screens, the case may be subject to a variety of analyses depending upon the amount of specimen submitted and the case history. These analyses can include, but are not limited to: benzodiazepines by gas chromatography with electron capture detection, basic, acidic and neutral drug screens by gas chromatography mass spectrometry (GC/MS), GHB and 4-methyl GHB by GC/MS, sympathomimetics by GC/MS, gabapentin and baclofen by high performance liquid chromatography with diode array detection, and additional ELISA screens for fentanyl (1), phencyclidine (5), and oxycodone (25).

Results: The most commonly encountered drugs (occurrence of 10 or greater) are listed by class in the table below. The drugs are listed as the number of occurrences because many cases involved multiple drug/ethanol findings. The results are further broken down by occurrences of each drug individually. Opiate occurrences were hydrocodone 67, oxycodone 59, morphine 49, codeine 28, and hydromorphone 4. Benzodiazepine occurrences were alprazolam 110, clonazepam/7-aminoclonazepam 33, diazepam/nordiazepam 29, temazepam 9, oxazepam 5, lorazepam 4, midazolam 2, and triazolam 1. Antihistamine occurrences were promethazine 7, dextromethorphan 7, chlorpheniramine 4, diphenhydramine 4, orphenadrine 3 and, doxylamine 3. Analgesic occurrences were: propoxyphene/norpropoxyphene 7, gabapentin 6, fentanyl 4, tramadol 4, trazodone 2, and meperidine 1. Antidepressant occurrences were amitriptyline/nortriptyline 4, citalopram 4, fluoxetine 4, sertraline 3, bupropion 3, and venlafaxine 3. Barbiturate occurrences were butalbital 11. Others drug classes that were confirmed included: hypnotics - zolpidem 8; sympathomimetics - methylenedioxyamphetamine/methylenedioxyamphetamine 2, and phentermine 1; muscle relaxants -

cyclobenzaprine 3, metaxalone 1, and methocarbamol 1; antipsychotics - mirtazapine 1; anticonvulsants - phenytoin 2, and topiramate 1.

Drug Class	Number of Occurrences
1 Ethanol	446
2 Cannabinoids	230
3 Opiates	201
4 Benzodiazepines	158
5 Cocaine	111
6 Pseudoephedrine/Ephedrine	53
7 Carisoprodol/Meprobamate	29
8 Antihistamines	28
9 Methadone	24
10 Analgesics other than opiates	24
11 Antidepressants	21
12 Amphetamine/Methamphetamine	21
13 Barbiturates	11

Summary: The data show that a great majority of the drugs responsible for DUI cases in Ohio are not necessarily illicit drugs. With the exception of ethanol, law enforcement and legislators continue to focus their efforts on illicit drugs as far as improved legislation and control. The new Ohio per se law is a perfect example of this mindset. This law defines per se levels for amphetamine, cocaine, cocaine metabolite, heroin, 6-monoacetylmorphine, lysergic acid diethylamide (LSD), marijuana, marijuana metabolite, methamphetamine, and phencyclidine (PCP) in blood, serum, plasma, and urine. As reflected in the data above, only the cocaine and metabolite and the marijuana and metabolite play a significant role in DUI. For 2005, MVRCL had no positive PCP cases, no driving histories consistent with LSD use, and few amphetamine/methamphetamine positives compared to the benzodiazepine and opiate classes. Intact heroin is never detected in an ante-mortem biological specimen. A per se level for any drug in urine is not meaningful as far as supporting a direct relationship between the drug and the impaired driving at the time of the offense. Ohio does not utilize the drug recognition expert program. Therefore, based on the law, urine per se levels can legally stand on their own, independent of field sobriety tests or any other measurement of impairment. Although the committee that drafted this legislation had ample consultation with toxicologists from all over the state, the toxicologists' recommendations were largely ignored. Because of the new Ohio law and others like it, some laboratories may be tempted to concentrate on those drugs with per se levels and ignore the rest. As demonstrated by the data, adopting this practice would potentially miss a majority of the drugs responsible for altered driving in DUI cases.

DUI, Drug Per Se Level, Demographics

K29 DUID Case Studies — DRE Evaluations With Blood / Oral Fluid Drug Quarts

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After attending this presentation, attendees will: 1) appreciate the important factors used to evaluate a potential drug impaired driving case, including the role of a DRE officer, 2) learn about the pharmacology of specific benzodiazepines and opiates and their effects on driving, 3) consider oral fluid as a possible alternative matrix to blood or urine in DUI investigations based upon the strengths and weaknesses discussed.

This presentation will impact the forensic community and/or humanity by building a database of drug quantitations in blood to relate to driving impairment.

Drug impaired driving continues to be a societal problem and growing concern as the number of physician written prescriptions and

illicit drug use increase. Polydrug use further complicates the issue by making interpretation more difficult, frequently as the result of insufficient information to support an opinion. Unlike alcohol, drug concentrations are not correlative to behavioral effects, particularly in DUI cases. Furthermore, limited literature information is available correlating drug concentrations with standardized field sobriety tests and poor driving performance. The following cases are presented to support the need for more case specific data correlating drug concentrations to driving performance.

The first case involves a 43-year-old male charged with DWI (2nd offense) after a witness reported observing the suspect driving erratically on a major highway. The suspect failed the standardized field sobriety tests (SFSTs) administered by the arresting officer. The suspect claimed to suffer from chronic back pain, and several medications were seized from him including Oxycontin® (40 mg), diazepam (10 mg), Skelaxin® (metaxalone 800 mg), Lyrica® (pregabalin 75 mg), as well as other drugs that were not readily identified. The breath alcohol test was negative, so a DRE was summoned. Upon completion of the DRE evaluation, the officer opined that the suspect was under the influence of a CNS depressant and narcotic analgesic. Blood and urine samples were tested. The laboratory quantitatively determined diazepam (410 ng/mL), nordiazepam (481 ng/mL), oxazepam (48 ng/mL), and trace amounts of temazepam, as well as oxycodone (114 ng/mL). The laboratory did not test for metaxalone or pregabalin. The urine sample was presumptively positive for benzodiazepines, opiates, cannabinoids, and cocaine.

The second case involves a 38-year-old male nurse charged with DUI after a witness complained of his erratic driving to state police. The arresting trooper was also able to observe the driver's dangerous behavior while driving and pulled him over soon after. Upon initial contact, the driver was observed to be wearing his coat inside out and upside down. A recently filled prescription for lorazepam (0.5 mg) fell out of the suspect's pocket. The suspect failed initial SFSTs and the breath alcohol was negative, so a DRE was called. The DRE opined that the suspect was under the influence of a CNS depressant and cannabis. The suspect admitted to taking lorazepam on an "as needed" basis, but did not take it regularly. Physician affidavits were obtained verifying that the suspect was under their medical care and prescribed Ativan® and Seroquel®. The laboratory's findings reflected a blood quantitation of lorazepam (79 ng/mL). The laboratory did not test for the Seroquel®. The presumptive positive cannabinoids drug screen was subsequently confirmed negative for both THC and THC-COOH.

The last case involves a subject, who voluntarily participated in an ongoing study evaluating the applicability of oral fluids to DRE certifications/DUI investigations. Oral fluid testing is not new to forensic toxicology; however, the use of oral fluids in DUI cases is being developed. Oral fluids offer many potential advantages over conventional blood and urine matrix testing, particularly the ease of sample collection. Blood, urine, and oral fluid samples are collected from the volunteer who is under the influence of CNS depressants and narcotic analgesics. The results of each matrix are compared to one another and against the DRE's opinion.

All three cases reflect the laboratories' limitations in terms of the types of drugs tested and matrices used. Forensic Toxicology is an ever-expanding field that must consider ways to optimize and standardize testing through collaborative research and sharing of data.

DRE, Impaired Driving, Forensic Toxicology

K30 Dissociative Driving: Ketamine DUI Fatality Case Study

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After attending this presentation, attendees will understand the pharmacological effects of ketamine and how it may adversely affect driving tasks.

This presentation will impact the forensic community and/or humanity by demonstrating the adverse effects of ketamine on driving skills, motor performance, and behavior in an otherwise healthy individual.

Ketamine came into existence as a safer alternative to PCP. Even before PCP was withdrawn from the market due to its problematic adverse reactions in patients, pharmaceutical houses were looking for a safer alternative that would have less toxic behavioral effects. It was first synthesized in 1962 and patented in 1966 under the trade name Ketalar® and received FDA approval in 1970 as a general anesthetic. It is used as a short-acting induction anesthetic that provides a profound, rapid, dissociative anesthesia and a short recovery time. Low doses produce effects similar to PCP but doses in the anesthetic range (1mg/kg) produce experiences where the individual feels separated from his body, floating above his body and a near-death experience. This state, which users call the "K-hole," can either be spiritually uplifting or terrifying (heaven or hell). Ketamine is a synthetic, sedative, non-barbiturate that acts as a central nervous system depressant and produces a rapid-acting dissociative effect. It is used in the recreational drug market by illegally diverting from legitimate suppliers, allowing the liquid carrier to evaporate. The crystals are scraped into a fine powder and packaged. The first reports of ketamine abuse occurred in the early 1970s in the San Francisco and Los Angeles areas.

In this case report, a 27-year-old Caucasian male was the driver and sole occupant of a luxury sedan driving on a dry and clear Arizona freeway at two thirty AM on an early February morning. He attempted to exit this freeway for an unknown reason; however, in doing so, he hit a traffic sign and then continued about 1100 feet until colliding head-on with a large steel sign post. The force of the collision caused the vehicle to rotate 180 degrees and caused very extensive front end damage with major intrusion into the cab area of the automobile. It was reported that the decedent was not wearing a seat belt and was not exceeding the posted 65 miles per hour speed limit.

A full autopsy was performed approximately 48 hours after death was pronounced and cause of death was determined to be massive blunt force trauma due to head and neck (fractured and dislocated) injuries. These included transection of the cervical spine, laceration of the pericardial sac, transection of the thoracic aorta, bilateral rib fractures, and contusions of all lobes of the lungs and multiple splenic lacerations. The manner of death was accident. During autopsy the assistant medical examiner collected pleural blood, bile, vitreous and gastric contents for complete toxicological testing. Vitreous and blood were analyzed for volatiles by GC-FID while the pleural blood was assayed by ELISA for benzodiazepines, barbiturates, benzoylecgonine, opiates, and methamphetamine with negative results. The blood and bile specimens were subjected to a qualitative analysis for basic drugs, and ketamine and its metabolites were confirmed by GC/MS using electron impact ionization. Quantitation of the ketamine was performed on the pleural blood with the result being 1.5 mg/L of parent compound. Further quantitative testing of all tissues submitted will also be presented.

A presentation of this case study will contribute to establishing guidelines on potential impairment concentrations of ketamine as it relates to DUI cases. Although this case demonstrates only anecdotal evidence for DUI impairment, it clearly demonstrates the adverse effects of ketamine on driving skills.

Ketamine, DUI, Fatality

K31 Methadone and Impaired Driving

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After attending this presentation, attendees will learn about the growth in the incidence of methadone in death investigation and impaired driving casework and some of the considerations in presenting methadone evidence in court.

This presentation will impact the forensic community and/or humanity by demonstrating how methadone is increasingly encountered in the forensic toxicology community and in the population of drivers arrested for DUI drugs. The relevant literature has few references to methadone-impaired driving and this data will be valuable to practitioners encountering the methadone-impaired driver.

The Washington State Toxicology Laboratory performs analysis in death investigation and criminal cases. It has previously reported an increased incidence of methadone¹ in casework, and the rise in both the number of methadone positive cases and the overall percentage of cases received has continued. In 1993, the laboratory reported 20 positive methadone cases which represented less than 0.5% of the casework. In 2005, this had risen to 640 methadone positive cases representing 6.7% of all cases received. Of these, 237 were drivers arrested for investigation of Driving Under the Influence (DUI). These increases are due in part to an increased use of methadone prescriptions for chronic pain management. Laboratory staff are often asked to evaluate the role of methadone in impaired drivers, which is often complicated by polypharmacy. This report will review the demographics, performance and behavior, and toxicology findings in a series of drivers arrested under investigation of DUI.

There are reports in the literature suggesting that methadone does not cause impairment among patients on a stabilized methadone dose². Baselt states, "narcotic-tolerant subjects can be stabilized on methadone replacement therapy with few subjective or objective effects on performance"³. The current study was undertaken to evaluate the role of methadone in impaired drivers. Toxicology reports of methadone positive drivers arrested for DUI from 2000 through 2005 were reviewed. There were 629 subjects, 62% of whom were males, mean and median age of 41 and 42, respectively with a mean and median methadone concentration of 0.21 and 0.15 mg/L. Methadone was rarely the only significant finding in these cases; approximately 98% of drivers are positive for at least one other psychoactive substance besides methadone, which is comparable to a rate of 92% in post-mortem cases. This group included 32 cases where methadone was the only psychoactive drug present in the suspect and where the subject was evaluated by a Drug Recognition Expert (DRE). Of this group, 75% were males, mean and median age was 40 and 42 respectively, and the mean and median methadone concentrations were 0.26 and 0.27 mg/L. Forty-two per cent were involved in a collision and 45% were stopped for erratic lane travel. A third of the erratic drivers were weaving so severely, that cell phone callers notified police of the potential DUI. The collisions most often involved striking parked vehicles, in one case the driver, while attempting to park drove up onto a curb, "deep-trunked" a parked vehicle, backed up and drove over the curb again.

The observations made on these subjects were compared with the signs and symptoms associated with narcotic analgesics from the DRE examination. Pupil sizes were consistently constricted in room light, near darkness, and in direct lighting conditions; there was little to no reaction to light and muscle tone was described as flaccid. These observations were consistent with the DRE matrix. Blood pressure and pulse rate varied widely, while the DRE matrix predicts that they would both be below the normal range. On the psychophysical tests, the subjects averaged 5/8 on the walk and turn, 3/4 on the one leg stand and 2" of sway on the Romberg balance. Time estimate was not a consistent marker for methadone impairment but they generally performed poorly

on the modified finger to nose test. Approximately half of the subjects had slurred speech and 75% were described as having droopy eyelids.

In one case, a 35-year-old male collided with another vehicle in the same lane of travel. When officers arrived at the scene, the subject was seated in his vehicle and appeared to be "nodding off." The subject voluntarily performed the standard field sobriety tests for the responding officer after which a DRE officer was called to the scene. The DRE officer noted that the subject had slurred speech, watery eyes, and droopy eyelids. He continued to "nod off" during his transport to the local precinct. He also repeatedly asked the same questions of the officer throughout the evaluation, without recognizing that he asked the same questions previously. On the Romberg balance he exhibited 2 to 3 inches of sway and he asked to repeat the test 3 times with his 30 second time estimates being 36, 45 10 and 76 seconds, respectively. He exhibited 6/8 clues on the Walk and Turn with his legs shaking throughout the test. His legs also shook on the One Leg Stand and he exhibited 3/4 clues. He only had one correct touch (of six attempts) on the Modified Finger to Nose. He did not exhibit Horizontal Gaze Nystagmus (HGN), Vertical Gaze Nystagmus (VGN), or a lack of convergence. His pupil sizes were 2.5 mm in room light (within normal range); 3.0 mm in darkness (below normal range) and 2 mm in direct light (within normal range) and he showed very little reaction to light. His pulse rate was elevated (100, 108 and 106) and his blood pressure was elevated 172/90. His muscle tone was described as rigid. He admitted to 30 mg of Methadone for chronic pain approximately 3.5 hours before the collision. The subject was arrested for DUI-drugs and his blood toxicology report was positive for methadone, at 0.27 mg/L, EDDP - methadone metabolite, nicotine, and caffeine.

Seventy-eight per cent of these subjects admitted to methadone use, with 31% indicating they were participants in an Opiate Treatment Program (OTP) and 34% indicating they were taking methadone for chronic pain treatment.

The data support the position that methadone can impair driving both for subjects in opiate treatment programs and for patients receiving it for treatment of chronic pain, and provide some parameters for comparison without complication of co-ingestion from other impairing drugs.

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Impaired Driving, Methadone, Drug Recognition Expert (DRE)

K32 Altered Pharmacokinetics of Delta 9-tetrahydrocannabinol

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The goal of this presentation is to provide forensic toxicologists and pathologists additional factors to consider in interpreting drug levels following traumatic injuries.

This presentation will impact the forensic community and/or humanity by helping in the understanding of the relationship between delta-9-tetrahydrocannabinol (THC) and driving impairment;

understand pharmacokinetics of THC; and understand some factors that could affect THC metabolism.

Marijuana is the common name for a crude drug made from the plant *Cannabis sativa*. It is commonly used for its euphoric effects. The main mind-altering (psychoactive) ingredient in marijuana is delta-9-tetrahydrocannabinol (THC). Some immediate physical effects of marijuana include a faster heartbeat and pulse rate, bloodshot eyes, and a dry mouth and throat. Smoking marijuana results in rapid absorption and is measurable in plasma within seconds after inhalation. Peak THC plasma concentrations occur prior to the end of smoking, and vary depending on the potency of marijuana and the manner in which the drug is smoked. In general, peak THC serum levels typically exceed 100 ng/mL and then fall rapidly: within 2 hours plasma THC concentrations are at or below 5 ng/mL. As a result, detection times in the blood are typically only a few hours after past use. THC has a large volume of distributions and is highly protein bound. THC is eliminated from plasma in a multiphasic manner. Metabolism of THC occurs via the hepatic Cytochrome P450 enzyme system. The major metabolite is 11-nor-delta-9-tetrahydrocannabinol-9-carboxylic acid (THC-COOH).

Marijuana has been shown to impair performance on driving simulator tasks and on open and closed driving courses for up to approximately four hours. Decreased car handling performance, increased reaction times, impaired time, and distance estimation, inability to maintain headway, lateral travel, subjective sleepiness, motor incoordination, and impaired sustained vigilance have all been reported. In 2004 in British Columbia, Canada approximately 25% of drivers involved in fatal accidents had evidence of marijuana use as determined by blood and urine detection of THC or THC-COOH.

A 16y old male driver presented in the emergency department with multiple blunt force injuries sustained during a single vehicle crash. Plasma samples that were collected in the ED for analysis had been determined to have concentrations of THC of 460 nmol/L (0.14mg/L), and a THC-COOH of 110 nmol/L (0.038 mg/L). The individual stated that he smoked marijuana prior to the incident, but that it was a couple hours prior to the sample collection. Based on the THC and THC-COOH concentrations using previously published algorithms, it is predicted that marijuana was smoked less than one hour prior to the sample collection. This contradicts the individual's claims.

Many physiological factors lead to altered pharmacokinetics parameters of commonly prescribed medications, including shock, altered blood flow, and altered perfusion of vital organs. The case demonstrated altered THC pharmacokinetics potentially due to traumatic injuries sustained by the individual.

Driving Impairment, Delta-9-tetrahydrocannabinol (THC), Pharmacokinetics

K33 Methamphetamine Impaired Driving in Arizona

John J. Musselman, BS, and Anil Solanky, MS, Phoenix Police Department Crime Laboratory, 620 West Washington, Phoenix, AZ 85003*

After attending this presentation, attendees will learn of the harmful combination of the methamphetamine lifestyle and driving.

This presentation will impact the forensic community and/or humanity by exposing common driving errors, individual behavior and observations, drug recognition expert (DRE) evaluations, and quantitation of amphetamine and methamphetamine in DUID cases. Specific case studies will be presented.

Although ethanol impairment continues to dominate in the workload, CNS stimulants, primarily methamphetamine has become the second most common drug(s) found in both blood and urine of drivers cited in driving under the influence of drugs (DUID). Urine is collected

in misdemeanor DUID cases and blood is collected in more serious felonies and fatalities when impairment is suspected. Vehicular behavior and/or the reason for stop prior to evaluation can be more difficult to obtain. Furthermore, evaluation of an individual by a DRE can be limited due to refusal, uncooperative, combative, or injured person. Sometimes vehicular behavior is the best indicator of impairment; sometimes it is the only indicator. Obtaining accident reports, field officer's notes and DRE evaluations and collation of the information can be a very useful tool when an opinion on impairment is asked of the toxicologist.

Amphetamine, methamphetamine were analyzed quantitatively as TFA derivatives with d5 amphetamine/d9 methamphetamine as internal standards. A review of 31 cases in 2004 where methamphetamine was the only significant finding, the average amphetamine concentration was 49ng/mL (median 33, range 10-160) and methamphetamine was 470ng/mL (median 330, range 63-1700). A breakdown of the blood methamphetamine levels; twelve (38%) were <200 ng/mL (considered "therapeutic"), and four (13%) were >1000 ng/mL. Acetone was qualitatively identified in the blood in three (10%) of the samples. When analyzing samples for blood ETOH, acetone and the absence of ethanol in DUI cases was a good indicator of CNS stimulant use.

Amphetamine/Methamphetamine (A/M) ratios ranged from 2-38%, with only four cases (13%) having (A/M) ratio <5%, indicative of an acute dose. Laboratory data suggests that the majority of these individuals are likely impaired due to the "down-side" or withdrawal effects of methamphetamine.

Methamphetamine users are mostly white males. A high percentage (approx 50%) of users are unemployed, have a suspended or no driver's license, no insurance, etc. The most common drugs found with samples containing methamphetamine are in decreasing order THC, benzodiazepines, and cocaine/BE. While DUI Ethanol arrests occur 80% of the time between the hours of 8:00 pm to 4:00 am, methamphetamine users are apprehended around the clock. Driving infractions included speeding, erratic driving, cross-center line collisions, red light, rear-end collisions, asleep at the wheel, and stolen vehicle and/or plates. Observations by officers (not necessarily DREs) include blood-shot watery eyes; slurred, mumbled, or incoherent speech; restlessness and body tremors. Evaluations performed by DREs demonstrated the best indicators of stimulant use were; the lack of horizontal gaze nystagmus (HGN), body tremors, pulse (n=14) mean 99 (60-136), and pupil measurement in dark room (n=5) mean 7.6 mm. Data from 2005 is currently being collected and will be presented, along with case studies.

Methamphetamine, Driving, Impairment

K34 Discovery and the Forensic Toxicology Laboratory

E. Warren Street, JD, Laboratory Corporation of America, 7777 Forest Lane, Suite C350, Dallas, TX 75230*

After attending this presentation, attendees will understand which provisions of the voluminous Federal Rules of Civil and Criminal Procedure directly apply to them in their routine production and retention of data, records, and documentation.

This presentation will impact the forensic community and/or humanity by identifying the specific rules of discovery that obligate the forensic scientist to maintain forensically defensible records of their work. The focus will be on those rules that may conceal inherent legal pitfalls for the prosecutor, plaintiff, or defendant who is not diligent in their request for the production of documents and witnesses.

The Federal Rules of Civil Procedure (FRCP) were promulgated by The United States Supreme Court. They were subsequently modified, ratified, and adopted by the Congress in 1938. Rule 16 of the Federal Rules

of Criminal Procedure was likewise adopted in 1946. During the intervening years the Rules have been further modified, amended, and expanded.

The term “discovery” encompasses the methods by which a party or a potential party to a lawsuit or prosecution obtains and preserves information regarding the action.

The Federal Rules of Civil and Criminal Procedure specify in considerable detail the means by which discovery may be used by plaintiffs, prosecutors, and defendants to compel the production of such data, witnesses, and documents as are needed at trial. It will also be emphasized that, while most states have adopted part or most of the Federal Rules, due diligence is essential in determining what deviation from the Federal Rules exists in a given jurisdiction, if the litigation is going to be heard in a state court.

Discovery in Civil matters is controlled by the Federal Rules of Civil Procedure, Rules 26 through 32. Discovery in criminal matters, greatly restricted by the constitutional protection against self-incrimination on the part of the defendant, is controlled by the Federal Rules of Criminal Procedure Rules 15 through 17 and Rule 26.2. Those instances where certain Federal Rules of Evidence are closely linked to the procedural rules will also be covered.

In civil matters, the duty to disclosure is essentially equal between the parties. This presentation will closely examine FRCP Rule 26 in particular and how it relates to the retention of experts. It will provide clear distinction between the consulting expert and the testifying expert in their obligation to disclose information.

Federal Rules, Discovery, Scientific Documents

K35 Discovery Issues: Deposing the Forensic Toxicologist

Harry L. Miles, JD, Green, Miles, Lipton, & Fitz-Gibbon, LLP,
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After attending this presentation, attendees will learn how to help the attorneys who engage them prepare them for written discovery requests, depositions and how to respond to discovery requests and questions so that the truth prevails. The presentation will aid the forensic community by helping the American justice system find the truth in contested criminal and civil matters. The presentation will focus upon the obligations of the experts and the attorneys to zealously represent their clients’ interests without violating their ethical obligations.

This presentation will impact the forensic community and/or humanity by demonstrating the practical preparation needs and potential pitfalls discovery may impose upon a toxicologist.

State and Federal rules of civil and criminal procedure impose discovery obligations on each party. Experts may have trouble reconciling their professional ethics with discovery practices under the rules of procedure. The presentation will discuss the practical needs of attorneys for expert opinions and the ways in which experts can provide those opinions in good conscience. In addition, the presentation will inform the attendees of the tricks, traps and pitfalls they may encounter when they respond to written discovery requests or testify at depositions. The manner in which deposition testimony may be used against an expert who testifies at trial will be demonstrated.

Discovery, Experts, Ethics

K36 The Role of the Forensic Expert in the Discovery Deposition: Communication is Key

David M. Benjamin, PhD, 77 Florence Street, Suite 107, Chestnut Hill, MA 02467*

The goals of this presentation are to review rules of evidence and procedure essential to quashing abusive discovery requests, develop the ability to actively listen to questions, recognize unclear questions, and practice asking for clarification.

This presentation will impact the forensic community and/or humanity by empowering forensic experts with information about how to prepare for a deposition, and providing instruction on the importance of listening to every word in a question before answering.

The “Discovery” phase of litigation is designed for each party to inquire about various positions of the other side and request production of important documents. After documents have been exchanged, experts may be asked to prepare a report memorializing their findings and opinions. The parties exchange expert reports and in jurisdictions where expert depositions are allowed, each party may elect to take the deposition of one or more of the opposing experts. A deposition is sworn testimony outside the presence of a judge and jury. Any fact witness or expert who has been disclosed (designated to be called as a witness at trial) may be asked to submit to a deposition. If you are to be deposed, you will probably receive a subpoena *duces tecum* asking you to bring certain documents to your deposition. Responding to the subpoena requires collaboration between the deponent and the attorney who retained him/her in order to determine the propriety of the requested documents.

Testifying as an expert in toxicology, or preparing your client for his/her deposition involves not only a thorough review of the facts of the case, but the ability to report one’s findings in an oral question and answer format. To be an effective witness, the deponent (individual being deposed) must be able to wade his/her way through the confrontational mine field of rhetoric and subterfuge that pervades much “lawyer-talk,” learn to recognize, and respond to trick questions. While experts have spent decades becoming proficient in their areas of specialty, attorneys have spent years learning how to phrase questions designed to elicit admissions and concessions, or to make you look foolish or unqualified.

This presentation is designed to teach you to develop “Active Listening” skills you can use to recognize improper or poorly framed questions, and to empower you with insights into the deposition process that will permit you to avoid providing an even worse response to a poorly phrased question. The seminar will begin with a review of the roles an expert can play in the legal system and continue with a brief review of the rules of evidence and civil procedure which control discovery requests, subpoenas, and provide for limiting and quashing abusive discovery requests.

The workshop will proceed to examine the objectives of a deposition and what types of questions to anticipate. Examples of good and bad deposition testimony and a review of an excellent deposition instruction provided by one attorney to a deponent will be presented.

Responding to Subpoenas, Preparing for Your Deposition, Developing Active Listening Skills

K37 A Rapid Increase in Fentanyl-Related Deaths in Detroit — A Twelve Month Review

Daniel S. Isenschmid, PhD*, Bradford R. Hepler, PhD, Denice M. Teem, BS, and Carl J. Schmidt, MD, Wayne County Medical Examiner's Office, 1300 East Warren Avenue, Detroit, MI 48207

After attending this presentation, attendees will be aware of the statistics associated with a large increase in fentanyl-related deaths in the Detroit area in the past year.

This presentation will impact the forensic community and/or humanity by raising awareness of a public health issue related to the dangers in the use of street drugs and by making the toxicologist aware of the need to include fentanyl in their drug abuse screens.

Beginning in late August 2005 there was a rapid increase in fentanyl-related deaths observed by the Wayne County Medical Examiner's Office (WCMEO). Most of these deaths were also associated with cocaine and/or heroin use. A year later there have been a total of 132 deaths associated with fentanyl in combination with these drugs.

Reports from crime laboratories from the analysis of exhibits and seizures from clandestine laboratories suggested that illicit fentanyl was being manufactured and sold by itself or mixed with heroin or cocaine. Street names for the drug combinations have included "suicide," "drop dead", "reaper", "penicillin", "lethal injection" or "crazy" stamped on the packets.

The WCMEO has routinely looked for fentanyl in its GC/MS screen (LOD 5 ng/mL) since 1999 in cases pending for toxicology and deaths due to accident or suicide. Prior to 2002, the incidence of fentanyl never exceeded 10 per year. Due largely to increased use and abuse of fentanyl patches and lollipops the incidence of fentanyl (defined as confirmed in any specimen) in postmortem examinations has gradually increased to 12 (2002), 20 (2003), and 29 (2004). For the first 8 months of 2005 there was an incidence of 15 cases in which fentanyl was detected, but by the end of the year that number rose to 63. For the first eight months of 2006 the incidence surged to 159. Due to the large increase in fentanyl associated cases, the WCMEO has since instituted a blood fentanyl screen by ELISA (Immunoanalysis®, Pomona, CA). This allows the laboratory to perform a rapid screen for the drug in more cases than before using a cutoff of 2 ng/mL. The assay shows good separation around the cutoff when using controls at 1 and 4 ng/mL.

Since May 2005, confirmation and quantitation of fentanyl has been performed at the WCMEO using GC/MS SIM (LOD = 1 ng/mL). Prior to that date, fentanyl was quantitated at a referral laboratory. Table 1 shows a statistical break down of the fentanyl concentrations determined in cases attributed to the fentanyl-laced deaths. In most cases heart blood was available. When iliac blood was available it was analyzed and the heart blood to peripheral blood ratio was calculated. Some of these ratios were quite high. Although post-mortem redistribution of fentanyl is possible, some of these deaths involved finding the decedent with a syringe still in the arm or groin, suggesting that early, partial drug distribution may also play a role in some high blood to peripheral blood ratios.

Table 1: Fentanyl concentrations (ng/mL) and Heart / Peripheral concentration ratios

	Heart Blood	Iliac Blood	Ratio Heart/ Iliac
Mean	33	17	2.7
Median	23	14	2.0
Range	3 – 190	3 – 69	0.47 – 10.7
N	155	85	80

From the first combined drug death on August 28, 2005 – August 31, 2006 the following number of cases were reported: fentanyl and heroin (as

6-acetylmorphine in blood or vitreous humor) (50), fentanyl and morphine (suspected heroin) (5), fentanyl and cocaine (includes benzoylecgonine) (36), fentanyl, heroin, and cocaine (41). Excluding hospital-administered fentanyl, another 41 deaths were due to fentanyl intoxication by itself or in combination with other prescription drugs. The fentanyl in most of these cases was suspected to be from illicit sources although a few of these cases included patch abuse and lollipop abuse. The overall incidence of ethyl alcohol in these cases is quite low (21%).

The demographics of the population were interesting and suggested widespread use of the combination of drugs throughout the metropolitan area. The WCMEO serves all of Wayne County (population 2 million) which includes Detroit (population 885,000). In the 2005 census, the population of Wayne County as a whole was 54% white and 42% black with City of Detroit population being 12% white and 82% black. For the fentanyl-related deaths the majority of decedents were male (67%), white (62%), were non-Detroit residents (53%), and between 40-59 years of age (64%). Only five cases were under the age of 20 although 17% of cases were between 20 and 29 years of age. Most were found dead at the scene (35%) or in their home (41%). Relatively few made it to hospital and many were dead on arrival.

In most cases, the medical examiners have reported the cause of death by listing the drugs present (e.g. cocaine, heroin and fentanyl intoxication) although if additional prescription drugs were present they may report the cases as multiple drug intoxication. The manner of death was accident in all of the cases.

After excluding hospital administered fentanyl, the relative lethality of fentanyl (defined as the percent of cases signed out as a drug related death when the drug is present) is exceeded only by carbon monoxide when present in blood. For all cases in which fentanyl was present acutely in addition to cocaine and / or heroin during this 12-month study period, only one case, a pedestrian, did not die directly from the drug combination.

Fentanyl, Heroin and Cocaine, Deaths

K38 Two Pediatric Methadone Fatalities: Case Reports From the Office of the Medical Examiner, Phoenix, Arizona

Kim G. McCall-Tackett, BS*, Amy L. Lais, BS, Diane J. Mertens-Maxham, BS, Vladimir Shvarts, MD, and Norman A. Wade, MS, Maricopa County Medical Examiner, 701 West Jefferson Street, Phoenix, AZ 85007

After attending this presentation, attendees will be afforded a review of two recent pediatric methadone related deaths.

This presentation will impact the forensic community and/or humanity by demonstrating that these analytical results will contribute to the limited data available on pediatric methadone cases.

The authors will present information about two recent pediatric deaths attributed to methadone toxicity. The analytical results presented are significant for their contribution to the limited data on methadone in a pediatric population.

Methadone, a synthetic opioid, was first synthesized by German scientists during World War II. It became clinically available in the United States in 1947 for treatment of narcotic addictions and later used for the treatment of chronic pain. Despite concern about the increased prescription of methadone and methadone related deaths, there is little information about incidence and associated toxicity in children. Prior use and cellular tolerance is of particular significance in evaluating blood concentrations. As documented in the literature, blood concentrations in a fatal overdose can vary greatly, with overlapping therapeutic and lethal ranges.

Case #1: A 12-year-old female was found unresponsive in her bedroom by family members. Emergency medical personnel were summoned, but resuscitation efforts were unsuccessful and death was pronounced at the scene. A full autopsy was performed approximately 55 hours after death was pronounced. Significant findings were elevated lung and brain weights consistent with edema. Pleural fluid, bile, vitreous fluid, gastric contents, liver, spleen, and brain were collected and submitted for toxicological analysis. Volatiles were assayed by GC-FID. Ethanol was present in the vitreous fluid at 0.01 g% and 0.07 g% in the pleural fluid. The blood was screened by ELISA for benzodiazepines, barbiturates, benzoylcegonine, opiates, and methamphetamine with negative results. The blood and bile specimens were subjected to a qualitative analysis for basic drugs. Methadone and metabolites were confirmed by GC/MS. The methadone was quantitated by GC-NPD in all specimens with results as follows: Pleural fluid 0.70 mg/L, liver 5.98 mg/kg, spleen 3.43 mg/kg, brain 1.15 mg/kg, and gastric contents 111.27 mg/L. The cause of death was determined to be methadone toxicity, and the manner of death was ruled a suicide.

Case#2: A 5-year-old male was found unresponsive in bed by his father. Emergency medical personnel were summoned, but resuscitation efforts were unsuccessful, and death was pronounced at the scene. A white foam cone from the nose and a reddish purge from the mouth were noted by medical examiner personnel. The decedent's prior medical history includes recent fever and congestion, autism, and asthma. A full autopsy was performed approximately 24 hours after death was pronounced. Significant findings include marked cerebral edema, heavy lungs, and an enlarged heart. At autopsy, cardiac blood, urine, bile, vitreous fluid, and gastric contents were collected and submitted for toxicological analysis. Volatiles were assayed by GC-FID with negative results. The blood was screened by ELISA for benzodiazepines, barbiturates, benzoylcegonine, opiates, and methamphetamine with negative results. The blood and urine specimens were then subjected to a qualitative analysis for basic drugs. The analytical findings are as follows: Methadone and metabolites were confirmed by GC/MS. The methadone was quantitated by GC-NPD and the concentration was found to be: Cardiac blood 0.34 mg/L, urine 8.36 mg/L, bile 0.63 mg/L, and gastric contents 23.8 mg/L. Also present in the cardiac blood were: Doxylamine 0.36 mg/L, Dextromethorphan 0.24 mg/L, and Acetaminophen 69.0 mg/L. The cause and manner of death are pending in this case, as it is still under investigation.

In both cases, a quantitative analysis of methadone consisted of a basic pH butyl chloride extract of sample and mepivacaine internal standard analyzed on an Agilent 6890 GC equipped with a nitrogen phosphorous detector (NPD). Analytical conditions consisted of a 260° C split injection (7:1) on to a 25m J&W Ultra 2 column programmed at 60° (1 minute) -10°/minute -315° (5.5 minutes). The concentration of methadone was determined by comparing the peak area ratios of methadone to the internal standard against a standard 4 point calibration curve. Linearity was demonstrated up to 1.0 mg/L, with fractional volumes being used for samples exceeding linearity.

A discussion of case circumstances will include past pediatric methadone cases, ruled undetermined and accidental, covering the ranges of 0.07 mg/L-0.46 mg/L toxicity levels of this synthetic narcotic.

Methadone, Pediatric, Fatalities

K39 Postmortem Concentrations in a Suspected Nikethamide Death

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After attending this presentation, attendees will learn about nikethamide, its use and potential toxicity, as well as postmortem concentrations found in blood, urine, liver tissue, and brain tissue in a suspected nikethamide death case.

This presentation will impact the forensic community and/or humanity by primarily providing the forensic toxicology/pathology community with postmortem concentrations in various bodily fluids and tissues from a suspected death case for which no readily apparent levels have been previously reported.

The decedent in this case was a sailor on a transport ship traveling from South America to the United States. Shortly after leaving a South American port, the individual in this case was discovered dead in the ship's engine room. A search of the decedent's cabin did not reveal any evidence of drug use; however, an investigation of the crew disclosed that the decedent, along with a couple of friends, went ashore and returned to the ship shortly before it set sail. As part of the postmortem examination, bodily fluids and tissues were submitted for toxicological testing. These tests included assays for carbon monoxide, alcohols, common substances of abuse and therapeutic drugs. The findings of the screen tests on cardiac blood detected and identified nikethamide by gas chromatography/mass spectrometry (GC/MS). Further quantitative testing for nikethamide by gas chromatography with nitrogen-phosphorus detection found 32 mcg/mL in cardiac blood, 3.6 mcg/mL in urine, 22 mcg/g in liver and 2.6 mcg/g in brain tissue. Other than an incidental finding of caffeine no other findings of toxicological significance were detected.

Nikethamide is a central nervous system (CNS) stimulant that causes an increase in the respiratory rate through its direct action on the brain or by indirect action on the carotid chemoreceptor. Although it has no direct effect on the heart or the blood vessels, it can cause an increase in the heart rate and blood pressure. It has been used to treat respiratory and/or circulatory depression caused by central nervous system agents such as barbiturates, alcohol, opiates, etc., as well as cholinesterase inhibitors and carbon monoxide. Nikethamide has also been used in patients in shock, respiratory failure secondary to chronic obstructive respiratory disease, and cardiac decompensation and coronary occlusion. It is available as a powder and as a solution for oral and parenteral injection. The usual dose is 0.5 to 1 gram intravenously, intramuscularly or subcutaneously. It is well absorbed and metabolized partly to niacinamide then further metabolized to N-methylniacinamide.

Nikethamide has a narrow margin of safety. The CNS stimulant effects produced by nikethamide for respiratory therapy may lead to generalized seizures and potentially death. As a result, the use of nikethamide as well as other similar types of drugs termed analeptics is strongly discouraged. Not only is nikethamide discouraged from clinical use, it is banned by the World Anti-Doping Agency. Nikethamide is on the NCAA Banned Drugs list forbidding its use. It also appears on several lists of banned substances in horse racing.

With no available information on blood or serum concentrations associated with nikethamide therapy or toxicity, or information regarding a lethal dose, the determined values were compared to reported levels of similarly acting analeptic drugs such as doxapram and pentylenetetrazol. Average peak plasma concentrations following a therapeutic infusion of doxapram ranged from 2.6 to 4.1 mcg/mL, with signs of toxicity expected at levels exceeding 9 mcg/mL of doxapram plus its metabolite, 2-ketodoxapram. Peak plasma concentrations of pentylenetetrazol following therapeutic dosages were reported to range from 1.5 to 3.1 mcg/mL.

Nikethamide, Postmortem, Toxicology

K40 Postmortem Redistribution of Phenobarbital: A Rat Suicide Model

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After attending this presentation, attendees will retain the importance of postmortem redistribution of phenobarbital (barbiturate), will understand grossly how redistribution works in a cadaver, and will learn some of the forensically important insect species in south-eastern Greece.

In this rat suicide model, phenobarbital is being used. It belongs to a category of drugs of which postmortem redistribution has not been studied for a long time. This presentation will impact the forensic community and/or humanity by demonstrating how the postmortem redistribution of a drug with this kind of profile is important to be known by a forensic toxicologist or forensic pathologist, so as to be able to interpret the results of blood, body fluids, and solid tissue samples.

Drug concentrations found in toxicological analyses of postmortem tissue, body fluids, and blood samples can lead to erroneous conclusions without the proper interpretation by the forensic pathologist, resulting in liability claims, insurance denials, and significant emotional turmoil for all involved. Postmortem redistribution of a drug may be the basis for elevated or toxic drug concentrations after death.

Postmortem redistribution refers to the processes by which diffusion of drugs and other chemicals takes place after death, from the gastrointestinal tract and solid organs to blood and other body fluids and vice-versa. This phenomenon is well recognized, and was first reported 25 years ago. Since then a considerable effort has gone into elucidating the processes responsible. Consideration of the redistribution of drugs is important in a variety of situations. Cases of suspected poisoning (either homicidal or suicidal) or cases where the drug concentrations are in the threshold of toxicity, as in vehicle accidents, and also potential cases of euthanasia or medical negligence, may rely absolutely upon the validity of toxicological analyses of blood and tissue samples obtained postmortem.

In this study, a suicide simulation model, 54 wistar rats were separated in six groups. In each experiment, six rats were sacrificed by intraperitoneal infusion of 300mg of phenobarbital dissolved in double distilled water (ddH₂O), and three by neck dislocation (controls). Each group was then exposed in open air for a different period of time: 0, 4, 5, 6, 7 and 8 days. At the times indicated the bodies were collected, and various carrion tissues (liver, kidneys, lungs, heart, and bloody fluid) and scavenger insect larvae were taken away for further analyses. For the toxicological analyses of the specimens (bloody fluid, tissue and larvae extracts), a Cobas Integra 400 plus (Roche Diagnostics) was used. This automatic analyzer performs measurements for the quantitative determination of drug concentrations using fluorescence polarization immunoassay (FPIA). In addition, scavenger insects were collected from the experimental scene, preserved in Kahle's solution, and were grouped and identified. Analytical climatological data were recorded, i.e. temperature (T, °C), relative humidity (RH, %) and rainfall height (r, mm), on an hourly basis.

The results indicate that there is a strong time-dependent linear increase in the levels of phenobarbital in the bloody fluid, heart, and lungs. In liver and kidneys a similar increase is initially noticed, but after the fifth day it is followed by linear decrease.

In larvae the decrease commenced the sixth day. The insects collected belong to the orders of diptera, coleoptera, and hymenoptera. The dominant order was diptera, family Calliphoridae, species *Lucilia sericata*.

Consequently, it is obvious that pathophysiology of decomposition plays an important and determinative role in the barbiturates related deaths. Various causes of death due to phenobarbital intake (suicidal deaths, euthanasia, accidental overdose deaths and homicides) can easily be confused. Death investigation and forensic toxicology are not immune to misinterpretation, as a large degree of error can arise from attempting to estimate antemortem drug concentrations based only on single postmortem measurements.

Phenobarbital, Suicide Model, Postmortem Redistribution

K41 Prevalence of Diltiazem in Cocaine-Positive Postmortem Cases in Maryland

Rebecca A. Jufer, PhD*, Barry S. Levine, PhD, and David R. Fowler, MD, Office of the Chief Medical Examiner, 111 Penn Street, Baltimore, MD 21201

After attending this presentation, attendees will learn about the prevalence of diltiazem in cocaine-positive postmortem cases in Maryland from 1995 through June 2006.

This presentation will impact the forensic community and/or humanity by providing information about the increasing prevalence of diltiazem as a cocaine adulterant.

Diltiazem is a benzothiazepine calcium channel blocker that is indicated for the treatment of hypertension, angina, and supraventricular arrhythmias. In therapeutic situations, diltiazem is typically administered in doses of 60-240 mg daily, producing therapeutic concentrations in the range of 0.1 to 0.3 mg/L. The plasma elimination half-life ranges from 2.8 to 9.2 hours. Adverse effects that have been reported with diltiazem use include weakness, edema, dizziness, nausea, and vomiting. Bradycardia, hypotension, and cardiac failure have been associated with diltiazem overdose.

In humans, diltiazem is extensively metabolized by O- and N-demethylation, deacetylation, N-oxide formation, and conjugation. Many conjugated metabolites are excreted in the urine, while less than 1% of a dose is excreted unchanged.

The Office of the Chief Medical Examiner of the State of Maryland has seen an increase in the frequency of diltiazem in cocaine positive postmortem cases in recent years. Cocaine positive cases received from January 1, 1995 through June 30, 2006 were reviewed to determine the prevalence of diltiazem in cocaine positive cases. Diltiazem and cocaine were identified in an alkaline drug screen, which involved an alkaline extraction of specimens followed by detection with gas chromatography /nitrogen-phosphorous detection and confirmation by gas chromatography / mass spectrometry. The results are summarized below.

Year	# COC positive cases	# COC and DILT positive cases	% DILT positive cases
1995	446	0	0.0%
1996	464	4	0.9%
1997	496	2	0.4%
1998	493	3	0.6%
1999	443	3	0.7%
2000	382	0	0.0%
2001	235	0	0.0%
2002	446	2	0.4%
2003	483	2	0.4%
2004	444	7	1.6%
2005	422	24	5.7%
2006- 1 st half	256	45	17.6%

As seen in the above data, there has been a dramatic increase in the number of cocaine positive cases containing diltiazem in the past year. The Drug Enforcement Administration first reported cocaine seizures adulterated with diltiazem in 2004.¹ Since 2004, there have been several additional reports of diltiazem adulterated cocaine seizures in various areas of the country.²⁻⁶ When quantitated, the diltiazem content of these seizures ranged from 8 to 20 %. These reports indicated that the reason for the selection of diltiazem as an adulterant is unknown.

The cardiotoxic effects of cocaine include hypertension, myocardial infarction, ventricular and supraventricular arrhythmias and tachycardia. As a calcium channel blocker, diltiazem could potentially offer some protection from the cardiac dysrhythmias induced by cocaine. One study examined the interaction between calcium channel blockers and cocaine in humans and found that pretreatment with diltiazem did not affect cocaine induced increases in blood pressure, heart rate, pupil size or subjective "high" ratings.⁷

Although the reason for adulteration of cocaine with diltiazem is unclear, the identification of diltiazem in a case may assist with identifying the source of the illicit cocaine. While there could potentially be an interaction between the two drugs, this trend is very recent in Maryland and the data are too limited to determine if the use of diltiazem as a cocaine adulterant has a role in cocaine-related death cases.

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³ Cocaine in Bamboo Sticks (From Guyana) at JFK Airport, New York. *Microgram Bulletin* 2006;39(6):73

⁴ Diltiazem, Hydroxyzine, and Methylephedrine Identified in Separate Shipments of Cocaine. *Microgram Bulletin* 2004;37(8):137

⁵ Cocaine Containing Diltiazem on the West Coast. *Microgram Bulletin* 2005;38(1):2

⁶ Unusually Sized and Packaged Cocaine Bricks in Rolla, Missouri.. *Microgram Bulletin* 2006;39(7):84

⁷ Rowbotham, MC, Hooker WD, Mendelson, J and Jones, RT. Cocaine-Calcium Channel Antagonist Interactions. *Psychopharmacology (Berl)* 1987;93(2):152

Cocaine, Diltiazem, Postmortem

K42 General Unknown Screening of Drugs and Toxic Compounds in Human Samples Using a Hybrid Triple Quadrupole/Linear Ion Trap LC/MS/MS System

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After attending this presentation, attendees will learn about using LC/MS/MS for a general toxicology screen. Sample preparation is simplified versus other screening techniques. This general screening technique also has the capability to detect unexpected drugs and metabolites, as well as targeted analytes.

This presentation will impact the forensic community and/or humanity by demonstrating a relatively new and novel screening technique that is, in general, simple and faster compared to most techniques. It allows faster and more specific detection and identification of analytes in a screening assay.

General unknown screening (GUS) procedures in clinical or forensic toxicology are used to detect and identify the exogenous compounds present in human samples, whether expected or not. A comprehensive LC/MS/MS GUS method has been developed for drugs, toxic compounds and their respective metabolites in biological fluids

A simple, non-selective solid-phase extraction sample preparation was used. The mass spectrometer is operated in the Information Dependent Acquisition (IDA) mode, where ions are selected from a single MS ion-trap survey scan and the two most intense ions are submitted for MS/MS acquisition. The complete cycle time lasts approximately 1.36 s. A library of MS/MS spectra of parent compounds and metabolites has been built up and the MS/MS spectra acquired can be searched against the library for analyte identification and confirmation.

This method proved to be very efficient to identify unexpected compounds in biological samples (as far as they corresponded to library entries), as well as to give clues about the presence of metabolites owing to MS similarities with their respective parent compound. More than 1000 MS/MS spectra in the positive mode and 250 in the negative mode were entered in the library, together with compound name, developed chemical structure, CAS number, retention time, relative retention time and UV spectrum. Clinical cases will be presented where compounds not found by other screening or target techniques could be identified unambiguously.

A unique combination of the innovative operating modes offered by hybrid triple-quadrupole linear ion-trap mass spectrometers and new software features rendered it possible to develop a comprehensive and efficient method for the General Unknown Screening of drugs, toxic compounds, and metabolites in blood or urine.

Toxicology, LC/MS/MS, Drug Screening

K43 Determination of Alprazolam in Oral Fluid

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After attending this presentation, attendees will learn the disposition of alprazolam in oral fluid and understand the degree of sensitivity necessary for its detection.

This presentation will impact the forensic community and/or humanity by demonstrating how, as oral fluid gains acceptance as a suitable specimen type for roadside collection, procedures for the detection of low level benzodiazepines are very important.

Methods: Oral fluid is increasingly being studied as a suitable matrix for roadside collection and determination of driving under the influence of drugs. A low dosage, potent benzodiazepine with anxiolytic properties, alprazolam, was selected for this experiment, due to its potential contribution to impaired driving. Benzodiazepines have not been widely detected in oral fluid since the saliva:plasma (S:P) ratio is less than 0.5 for most of the drug class. The newer benzodiazepines are also given in low dosage regimens making their detection in oral fluid even more difficult.

Extraction: Calibrators were prepared in Quantisal™ transportation buffer at concentrations of 0.1, 0.2, 0.5, 1, 2 and 5 ng/mL of alprazolam. Deuterated (d5) alprazolam was added at a concentration of 5 ng/mL. Mixed mode (cation exchange:hydrophobic) solid phase extraction columns were conditioned with methanol (3 mL), deionized water (3 mL) and 0.1M phosphate buffer (pH 6.0; 2 mL). The specimens were loaded onto the column and allowed to run through. The columns were washed with deionized water (3 mL) and 0.1M phosphate buffer:acetonitrile (80:20, v,v; 2 mL). The columns were dried for 5 minutes, then hexane (1 mL) was added. The alprazolam was eluted with ethyl acetate:ammonium hydroxide (98:2 v,v; 2 mL) and

evaporated to dryness. BSTFA + TMCS (50 μ L) was added and the samples were heated at 70°C for 45 min.

Analysis: In order to achieve the sensitivity necessary for the detection of low level anxiolytic benzodiazepines in oral fluid, a two-dimensional gas chromatographic system was employed, with negative chemical ionization mass spectral detection. The system functioned optimally when the phases of the two gas chromatographic columns were as different as possible. The primary gas chromatographic column was a DB-35 MS column (30m x 0.25mm ID x 0.25 μ m film thickness), the inlet pressure was 54.3 psi, and the average linear velocity was 81 cm/sec. The length of the restrictor column was calculated by software, and was dependant on the dimensions of the column and the pressure. The restrictor tubing was connected to the Deans switch and the other end was attached to a secondary detector.

In a Deans switch mode, the flow from the primary column plus a switching flow are passed onto the secondary column. The secondary column was a DB-1 stationary phase (15 m x 0.25 mm i.d. x 0.25 μ m film thickness). The Deans Switch (Auxiliary Port #3) was programmed to operate at a pressure of 31.2 psi. It allowed all the flow from the primary column to vent through the flame ionization detector for 11.2 min. For 1.1 min the flow was then switched to allow the carrier gas to enter the secondary analytical column. At 12.3 min, the flow was returned to the secondary vent.

In order to "trap" the analyte using the cryo-focusing unit, the focuser was cooled from the oven temperature of 280°C to 100°C beginning at a run time of 10.5 min. The ramp rate for cooling was as high as it was possible to set the software and was set at 777°C/minute. It was held at 100°C for 3 min, thereby allowing the alprazolam to trap in the cryofocuser. At a retention time of 13.5 min, the focuser was heated at a rate of 777°C/minute to a final temperature of 280°C.

Injection and Oven Parameters: The front inlet was operated in pulsed splitless mode at an initial temperature of 280°C. The pressure was 54.3 psi and the pulse time was 1 minute. The purge flow was 20 mL/min and the purge time was 1 minute. The injection volume was 2 μ L.

The oven was programmed from 190°C for 1 min; ramped at 30°C/min to 320°C where it was held for 10.67 min.

Mass Spectrometer Parameters: The instrument was tuned in negative chemical ionization mode, using ammonia. The flow of the ammonia collision gas into the source was maintained between 8.0 x 10⁻⁵ and 1.0 x 10⁻⁴ Torr. The MS source was held at 150°C, the quadrupole at 106°C, the transfer line at 280°C, and was operated at 800eV over tune. The MSD was operated in selected ion monitoring mode with four ions in a single group. Ions 313 and 315 were monitored for D₅-alprazolam; 308 and 310 for alprazolam with a dwell time of 50 ms for each ion. The retention time of alprazolam was 14.4 min. The method was linear over the range tested.

Results: The procedure was applied to specimens collected using the Quantisal™ oral fluid collection device, from a subject who was a prescription user of alprazolam. The profile of alprazolam detection over a time course of 16 hours after ingestion will be presented.

Summary: A method for the extraction and highly sensitive detection of alprazolam in oral fluid is described. The method was applied to oral fluid specimens taken from a prescription user of alprazolam.

Alprazolam, Driving Under the Influence of Drugs, Oral Fluid

K44 Stereoselective Determination of Methamphetamine From Urine Using Purge and Trap GC/MS

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After attending this presentation, attendees will be familiar with a stereoselective and sensitive methodology for the determination of methamphetamine in urine samples. Attendees will be familiar with this novel technique for separating methamphetamine isomers using PT-GC/MS. An indirect chiral separation using the optically pure chiral derivatizing reagent TPC is presented to the attendee. Attendees will understand the pre-concentration capabilities of dynamic headspace sampling and how pivotal it can be when analyzing biological fluids containing analytes at low concentrations. The attendee will be presented with analytical figures of merit for this technique and comparisons will be made with more traditional techniques such as SPE-GC/MS.

This presentation will impact the forensic community and/or humanity by providing the forensic community with a new analytical tool capable of identifying the individual isomers of methamphetamine in urine with minimal sample preparation. Such capabilities would not only assist forensic toxicologists, but would also provide a new technique capable of identifying enantiomeric ratios which provide pivotal information regarding the method and origin of clandestine methamphetamine synthesis.

Quantitative and stereoselective determination of methamphetamine from urine using purge and trap gas chromatography-mass spectrometry (PT-GC/MS) is described. Methamphetamine is an optically active sympathomimetic amine existing in two isomeric forms. The dextrorotatory [d-(+)] form of methamphetamine which is often prepared from ephedrine, induces central nervous system (CNS) stimulant effects and as a result is more widely abused than its legally available levorotatory [l-(-)] form. Although both enantiomers are considered controlled substances under United States regulations, there is still a need to develop enantioselective methodologies capable of distinguishing the illicitly manufactured d-isomer from the legally available l-isomer in various matrices. A wide variety of optically pure pre-column derivatizing agents have allowed for the enantioselective determination of many isomers in biological fluids using achiral chromatography. The method described here utilizes a rapid pre-column derivatization of the methamphetamine isomers using trifluoroacetylpropyl chloride (TPC), allowing subsequent separation of the diastereoisomers on an achiral GC column employing MS detection. In recent years, both direct and indirect chiral separations have utilized a wide variety of instrumentation including GC/MS, HPLC, CE, SFC, TLC, and CEC to successfully separate the isomers of many chiral drugs. Such methodologies are necessary due to the large number of drugs possessing chiral centers which are either used therapeutically or abused, and whose individual enantiomers induce varying degrees of therapeutic implications, side effects, or in the case of methamphetamine, CNS stimulation. New techniques capable of optically resolving these drugs on an analytical scale would allow analysts to further understand the pharmacokinetics associated with individual enantiomers of drugs known to undergo stereoselective disposition following administration. Methamphetamine is synthesized clandestinely with average purities ranging between 50-70%, and, although it is well documented that the d-isomer is responsible for the CNS stimulant effects, quantitative analysis of individual isomers can indicate the route and origin of synthesis. Although stereoselective

determination of methamphetamine from urine has been achieved prior to this study, significant sample cleanup and/or derivatization techniques have resulted in time consuming and challenging methodologies. Concentrations of methamphetamine in urine can vary significantly depending on the dose and whether or not the subject is a regular abuser. As a result there is often a need for sample extraction/pre-concentration from complex matrices. Solid-phase extraction (SPE) followed by pre-column derivatization has proven to be a successful preparative technique for the separation of methamphetamine isomers in urine using GC/MS; however there is a need for more convenient, time efficient techniques. The current methodology describes the stereoselective quantification of methamphetamine isomers in urine samples while reducing the degree of sample preparation. Rapid pre-column derivatization allowed for the subsequent extraction and pre-concentration of the diastereoisomers using dynamic headspace sampling followed by GC/MS.

Methamphetamine, Stereoselective, GC/MS

K45 Tissue Distribution of Drug Intoxication in Pediatric Fatalities

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After attending this presentation, attendees will have learned about the tissue distribution of lidocaine in a pediatric fatality as well as the tissue distribution of methadone in four pediatric fatalities.

This presentation will impact the forensic community and/or humanity by demonstrating the importance of obtaining multiple tissue samples for analysis in pediatric fatalities involving drugs as well as the need for co-operation between pathology staff and the toxicology laboratory.

Lidocaine is a local anesthetic. Case history and toxicological findings from one pediatric fatality due to lidocaine intoxication is presented. Methadone is an analgesic. Case histories and toxicological findings from four pediatric fatalities are presented.

In the first case, a two year-old black female complained about a sore in the mouth, was taken by her mother to a clinic. The subject was given a prescription for lidocaine and was found unresponsive two days later. The subject was transported to the hospital and expired on the following day. Lidocaine was detected in a basic drug screening and quantitated by Gas Chromatography, after solvent-solvent extraction with internal standard methodology. The presence of lidocaine was confirmed with full scan Gas Chromatography/Mass Spectrometry. The tissue distribution of lidocaine for the first case was as follows: blood, 2.52 mg/L; bile, 1.98 mg/L; liver, 0.76mg/kg; brain, 0.52 mg/kg; spleen, 7.20 mg/kg; and kidney, 2.68 mg/kg. The cause of death was bronchopneumonia due to lidocaine intoxication due to herpes stomatitis. The manner of death was listed as accident.

In the second case, an eighteen month-old black male drank a glass of orange juice with methadone on an end table and was found unresponsive later. The subject was hospitalized and died five days later. Methadone was detected in a basic drug screening and quantitated by Gas Chromatography, after solvent-solvent extraction with internal standard methodology. The presence of methadone was confirmed with full scan Gas Chromatography/Mass Spectrometry. The tissue distribution of methadone for the second case was as follows: blood, 0.10 mg/L; hospital blood (clotted, day two), 0.10 mg/kg; liver, 0.23 mg/kg; and brain, 0.23 mg/kg. The cause of death was methadone intoxication. The manner of death was listed as undetermined.

In the third case, a two year-old black male was found choking and gasping for air while in the bed. The subject was hospitalized and expired three days later. The tissue distribution of methadone for the third case was as follows: blood, negative; bile, 0.36 mg/L; and liver, 0.26 mg/kg. The cause of death was methadone intoxication. The manner of death was listed as undetermined.

In the fourth case, a five year-old black female began to choke and went into convulsions in the presence of her grandmother early morning. The subject died in the emergency room. On the day before, the subject might have drunk some of the orange juice with methadone, while riding with her mother and one of her mother's friends in her mother's car. The tissue distribution of methadone for the fourth case was as follows: blood, 0.64 mg/L; urine, 3.31 mg/L; bile, 2.18 mg/L; liver, 2.22 mg/kg; brain, 0.82 mg/kg; and spleen, 3.58 mg/kg. The cause of death was methadone intoxication, with parental neglect as a contributing factor. The manner of death was listed as undetermined.

In the fifth case, a fourteen year-old black male was playing in a football game for his high school and later on that night, was complaining to his parents of having a headache. Four days later, the subject was vomiting, so his parents told him to stay home from school. The subject was found unresponsive in bed when his father returned home from work. The tissue distribution of methadone for the fifth case was as follows: blood, 0.35 mg/L; liver, 2.70 mg/kg; spleen, 1.08 mg/kg; and kidney, 1.48 mg/kg. The cause of death was methadone intoxication. The manner of death was listed as accident.

In these pediatric fatalities, multiple tissue specimens were submitted to the toxicology laboratory when the pathologist requested testing. In the event, that a positive finding occurred, in one specimen from the case, the toxicology staff was then able to analyze multiple tissue specimens in order to provide a tissue distribution study. In pediatric fatalities, a positive finding of a drug usually implied that someone other than the deceased child/infant was involved with the administration of the drug in question. A tissue distribution study performed in this type of case will provide the toxicology findings as an unequivocal litigation package. Toxicologists are only able to do tissue distribution studies in cases such as these, with the full support of the pathology staff.

Lidocaine Tissue Distribution, Methadone Tissue Distribution, Pediatric Fatalities

K46 Sensitive Detection of Amphetamines and Other Basic Drugs Using Eosin Isothiocyanate

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After attending this presentation, attendees will understand the growing applications of microfluidic systems such as how they can be used to solve crimes as well as diagnosis health issues.

This presentation will impact the forensic community and/or humanity by demonstrating that microfluidic systems can perform extremely rapid analyses of compounds utilized in crimes such as Drug Facilitated Sexual Assaults and DUIs.

The application of microfluidic systems to toxicological screening and clinical diagnostics is growing rapidly. Rapid analysis of small molecules is essential in the detection of drugs for the prosecution of crimes such as drug-facilitated sexual assault and DUIs. Detection of biogenic amines for identifying health disorders and diseases is also of

interest. Therefore, these systems are of interest to both criminal investigators and medical personnel. Microfluidic systems utilize very small quantities of samples (μL s) and perform rapid separations (2 min. or less). Their small size makes them potentially portable for use at crime scenes. In addition microchips can be inexpensively, and the designs are simple to minimize user interaction. Quick analysis (preferably on-site) and high sensitivity are crucial to detection because some drugs can be metabolized and rapidly eliminated.

Although liquid phase drugs are traditionally detected by UV, its sensitivity is limited in microfluidic analysis by short path lengths (approximately $50\ \mu\text{m}$ or less). Fluorescence is by far the most common detection method utilized by microfluidic systems due to its high sensitivity. However, most drugs are not naturally fluorescent so analysis must be derivatized. Biogenic amines and many drugs of abuse which are primary or secondary amines can easily be derivatized by amine reactive dyes.

Alnajjar, et al presented a method for the derivatization of opiates and their derivation with fluorescein isothiocyanate (FITC) and detection by CE-LIF with a 488nm argon-ion laser.¹ The method presented is the detection of several phenethylamines, primary and secondary, by microchip CE-LIF. The drugs are derivatized by eosin isothiocyanate (EITC) and detected on a Micralyne microfluidic Tool Kit (μTK) equipped with a 532nm frequency-doubled laser. Tertiary amines can also be derivatized following a demethylation procedure.²

One of the advantages of microfluidic systems is their potential to perform simultaneous sample preparation, separation, and detection. This growing trend in microfluidics to create micro total analysis systems (μTAS) greatly improves the overall analysis speed. It has been shown that several phenethylamines³ and biogenic amines⁴ can be fluorescently derivatized in a few seconds making on-chip reactions feasible. A method for performing rapid derivatization of phenethylamines by EITC on-chip is proposed. Several chip layouts were tested to promote mixing of reagents, and very narrow reaction chambers improved mixing. The reactions were optimized by placing the mixed reagents in the dark at room temperature for 48 hours and measuring the product yield relative to an internal standard every few hours. Although it took about 24 hours for the reaction to go to completion, products formed at a detectable level in less than 10 minutes.

Derivatized amphetamine, methamphetamine, and ephedrine could be separated by CE with baseline resolution using a basic buffer, pH = 9.8, containing cyclodextrins and a separation voltage of 10 kV in a 40 cm long capillary. In addition microchip separation could be simulated on a traditional CE by injecting the sample on the short end of the capillary. The combination of the rapid microchip separation and the on-line sample preparation resulted in a μTAS which could perform a screening test in a matter of minutes.

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DFSA, Microfluidic, Fluorescence

K47 Validation of a Headspace-Gas Chromatography Method for the Analysis of Gamma-Hydroxybutyrate and Analogs

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After attending this presentation, attendees will have learned about the validation of a quantitative technique for the simultaneous analysis of GHB and GHV in beverages using an instrument common to toxicological analyses.

This presentation will impact the forensic community and/or humanity by demonstrating a quantitative technique for the detection of GHB and GHV in beverages using a common toxicological analysis.

Previous work from this laboratory has described validated headspace-gas chromatography-flame ionization (HS-GC-FID) and gas chromatography-mass spectrometry (GC-MS) method for screening and identifying gamma-hydroxybutyrate (GHB) and its lactone (gamma-butyrolactone, GBL) in biological fluids. An advantage of this approach is the use of the same analytical system as blood alcohol measurements; making this method readily available to toxicology laboratories. No sample preparation is required and the use of internal standards facilitates reliable quantitation.

Extensions of this method to other sample matrices and other target compounds will be presented. An analog of GHB, the five carbon gamma-hydroxyvalerate (GHV) and corresponding lactone (gamma-valerolactone GVL) have recently emerged as a predator drug threat. These analogs are characterized by larger dose requirements and thus greater potential for toxicity. Because of their chemical similarity to GHB/GBL, they are also amenable to this method. Results and method validation for these compounds will be discussed and compared to traditional GC-MS analyses. In addition, analysis of typical precursors and by-products will be addressed.

Headspace methods are also useful for physical evidence such as adulterated beverages. Given discrimination based on volatility and solubility, the headspace method effectively removes much of the interfering matrix while affording quantitative transfer of analytes to the analytical system. Results from the analysis of various beverages such as wine, beer, soda, and mixed drinks will be described with recoveries and interferences.

Headspace, GHB, GHV

K48 Rapid Analysis of THC and Metabolites Using Disposable Pipette Extraction

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After attending this presentation, attendees will understand a new and improved method for analyzing THC and metabolites in whole blood.

This presentation will impact the forensic community and/or humanity by assisting the forensic community to implement a faster and improved method for performing THC analysis.

A rapid extraction method for THC and metabolites has been developed using disposable pipette extraction (DPX). Although DPX has been previously introduced for this extraction methodology, improvements in the design of the DPX tips and changes in sorbent material have permitted higher recoveries and more reproducible data. Also, the extracts are much cleaner and negligible interferences were noted from actual case samples. Furthermore, the new method permits the simultaneous analysis of THC, OH-THC and COOH-THC in a single extract and thus single chemical derivatization.

The method involved extracting 1 mL of whole blood with 1.5 mL acetonitrile. After mixing, the supernatant was decanted into a clean labeled test tube and 2.5 mL of 0.1M HCl added. The mixture was drawn into the DPX tip using an attached 10 mL syringe device and mixed with the sorbent by drawing in air. After 30 seconds, the sample solution was dispensed back into the tube (or waste). Subsequently, 0.5 mL of methanol was drawn into the DPX tip and mixed as a wash step. For elution, 0.5 mL of 5:1 hexanes-ethyl acetate was drawn into the DPX tip, mixed with the sorbent by drawing in air, and after 10 seconds the eluent was dispensed directly into the corresponding labeled GC vial. The elution step was repeated with an additional 0.5 mL of 5:1 hexanes-ethyl acetate. The DPX extraction time, following the protein precipitation with acetonitrile, took approximately 3 minutes, and 12 samples could be processed simultaneously using 12 syringe devices.

Using BSTFA for derivatization, 3 ions (1 target and 2 qualifier ions) could be monitored for THC free from apparent interferences. GC oven temperature was held for about 5 minutes at 220 C to improve the chromatography and increased the resolution of interferences with THC. Detection limits were less than 0.5 ng/mL for THC and OH-THC and approximately 1ng/mL for COOH-THC.

THC, Disposable Pipette Extraction, Solid-Phase Extraction

K49 Evaluation of the Lin-Zhi International Opiate Enzyme Immunoassay for the Detection of Opiates in Urine

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After attending this presentation, attendees will learn the performance characteristics of the Lin-Zhi Opiate Assay, as they apply to urine samples and the availability of an alternate vendor for an opiate EIA method.

This presentation will impact the forensic community and/or humanity by reviewing current methods for opiate screening, with the characteristics of an alternate vendor to those currently available. At a

minimum, expand the current available information on how robust current opiate methodologies are.

The Opiate Enzyme Immunoassay [OEI] (Lin-Zhi International, Inc., Sunnyvale, CA) for the detection of opiates in urine. The Lin-Zhi assay is based on competitive antibody binding between opiates in urine and glucose-6-phosphatase dehydrogenase labeled morphine. The assay is calibrated with morphine.

The Lin-Zhi OEI was evaluated by testing 1212 urine specimens. All specimens were tested on an ADVIA 1200 Chemistry System auto-analyzer (Bayer Health Care, Diagnostics Division, Tarrytown, NY) with calibrators containing 0, and 300 ng/mL (cut-off calibrator) of morphine. Controls containing 0 ng/mL of morphine, 225 ng/mL (negative control) and 375 ng/mL (positive control) of the cut-off calibrator (Bio-Rad Laboratories, Irvine, CA) were analyzed with each batch of samples. All urines were then analyzed by a GC/MS for opiates at a cut-off concentration of 100 ng/mL.

Approximately, 58 % (711) of the 1212 specimens screened positive by the Lin-Zhi assay. GC/MS confirmed the presence of an opiate at >100 ng/mL, in 692 of the 711 specimens, indicating 19 false positive results. However, 88 specimens screening negative were found to contain an opiate above the GC/MS cut-off of 100 ng/mL (78 oxycodone and/or oxymorphone). Opiate concentrations in the specimens as determined by GC/MS, ranged from < 100 - >50,000 ng/mL. From the presented study, the sensitivity of the Lin-Zhi OEI was 0.887 and the selectivity 0.956. Testing at 1,000 mg/mL of other drugs of abuse or their metabolites such amphetamine, benzodiazepines, benzoylecgonine, morphine and phencyclidine, the Lin-Zhi assay demonstrated no cross reactivity. The within-run precision of the Lin-Zhi assay was determined by the absorbance rates of the negative and positive controls was CV£ 5% (n=8); while the between-run precision of the controls was CV=<5% (n=11). The assay was linear from 25% to 150% of cut-off concentration. The Lin-Zhi CBI provides a precise, reliable method for the detection of opiates in urine specimens.

Enzyme Immunoassay, Opiates, Urine Drug Testing

K50 Confirmatory Analysis of Ethylglucuronide and Ethylsulphate in Urine by LC/MS/MS According to Forensic Guidelines

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After attending this presentation, attendees will understand the use of LC/MS/MS technology to analyze alcohol metabolites.

This presentation will impact the forensic community and/or humanity by demonstrating a new LC/MS/MS based and validated method for the analysis of Ethylglucuronide and Ethylsulphate for forensic toxicology and workplace testing laboratories.

Ethylglucuronide (EtG) and Ethylsulphate (EtS) are stable Phase II metabolites of ethanol which can be detected in urine samples several days after elimination of ethanol. Determination in urine is mainly performed by LC/MS, LC/MS/MS, or by GC/MS. For the mass spectrometric identification and detection of controlled substances in sensitive fields such as forensic toxicology, workplace drug testing, doping analysis, and veterinary organic residue control, official guidelines have been released requiring a chromatographic separation and a minimum of two mass spectrometric transitions of detected analytes.

Therefore, an LC/MS/MS method was developed to detect the following transitions: deprotonated molecule of EtG [M-H]⁻ to product ions m/z 75, 85, 159 and EtS [M-H]⁻ to m/z 80, 97. Isotopically labeled internal standards were used to evaluate ion suppression effects. Simple dilution with water containing 0.1% formic acid followed by

centrifugation was found to be sufficient to prepare urine samples. HPLC separation was performed on a RP column using a gradient of water, acetonitrile, and formic acid. Post-column addition of acetonitrile was used to enhance sensitivity.

The method was validated regarding forensic guidelines. Urine samples were collected and analyzed after drinking experiments of volunteers. EtG and EtS were detected in these samples. Time plots are used to study the kinetics of metabolism of ethanol.

Ethylglucuronide, LC/MS/MS, Workplace Testing

K51 Driving Under the Influence of Drugs (DUID) Testing Protocol in the Commonwealth of Virginia

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After attending this presentation of the review of the driving under the influence of drugs protocol in Virginia, attendees will learn the system and see the stop analysis limits used in the state, which is related to the trial testimony.

This presentation will impact the forensic community and/or humanity by aiding toxicologists in reviewing testing protocol.

If law enforcement stops any driver suspected of DUID in the Commonwealth of Virginia, that driver is typically first administered a breath test for ethanol. If the ethanol result is too low to explain the police officer's observations, or if the suspect is unable to perform the breath test, the suspect is taken to a medical facility where two tubes of blood are collected. The blood samples are controlled under chain-of-custody until they arrive at the Department of Forensic Science Central Laboratory, usually via mail. One of the blood specimens is stored under chain-of-custody, and the other undergoes a graded tier testing scheme, developed to save resources and time and still assure the appropriate DUID analysis (i.e., full-spectrum drug analysis is not performed on each submission). The testing protocol will occur in at least one but up to five phases, as outlined below, and is referred to as:

- Level I Testing For Ethanol
- Level II Screen
- Level II Confirmation
- Level III Screen
- Level III Confirmation

All specimens receive Level I Testing for ethanol. When ethanol is $\leq 0.09\%$ no testing beyond Level I is required, unless circumstances dictate that further testing be performed (e.g., involuntary manslaughter). When ethanol is $< 0.09\%$, proceed to Level II Screening which includes immunoassay for barbiturates, cocaine/benzoyllecgonine, benzodiazepines, cannabinoids, phencyclidine, and opiates. Any presumptive positive Level II Screen will automatically require a Level II confirmation and quantitation. If any value reaches the "Stop Analysis Limit" testing is concluded. Some examples of the stop analysis limits for Level II drugs are butalbital 10 mg/L, alprazolam .06 mg/L, tetrahydrocannabinol 0.002 mg/L and codeine 0.5 mg/L. Negative results in Level II require Level III Screening, which includes a screen for alkaline extractable drugs. Any presumptive positive Level III Screen will automatically require a Level III confirmation/quantitation by gas chromatography/mass spectrometry.

The tier system was designed so that once a drug, or group of drugs, was found at a concentration high enough for probable conviction of driving under the influence of drugs or alcohol, no other testing was done to detect other drugs. Thus, there is a potential for all drugs other than ethanol to be under represented. This tier system presents a potential retrospective problem if there is a necessity to determine "total

drug usage by drivers" because the number of drugs found is clearly less than the "true or actual" number of drugs that were present in an individual at the time of the traffic stop. Underestimation is not a problem for ethanol because all blood samples were tested for ethanol. Using the tier system testing protocol causes Level II and Level III drugs to be under represented, but due to the design of the tier system, Level III drugs will be more severely under represented than the Level II drugs. Nevertheless, the tier system has proven quite successful in Virginia with regard to driver impaired convictions and enables more efficient utilization of resources and personnel in the Department of Forensic Science. Reporting limits and stop analysis limits are enumerated in this report.

DUID, Testing Protocol, Statistics Underestimation

K52 Methamphetamine and Phentermine in DUID Cases

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After attending this presentation, attendees will learn of some of the drugs frequently seen in combination with methamphetamine and of the effects on drivers impaired by such combinations. Phentermine is similar to methamphetamine, but is less potent as a sympathomimetic.

This presentation will impact the forensic community and/or humanity by demonstrating that a complete toxicological assessment is essential for the correct classification of the methamphetamine impaired driver.

This presentation will describe several Driving Under the Influence of Drugs (DUID) cases involving the sympathomimetic amines, methamphetamine, and phentermine. Methamphetamine produces a multi-phasic response with an initial excitation that is replaced, as drug levels decline, by feelings of drug craving, agitation, fatigue, and hypersomnolence. Users often co-administer alcohol, or other substances, such as anxiolytics, in attempts to "soften the crash."

By attending this presentation, attendees will learn of some of the drugs frequently seen in combination with methamphetamine and of the effects on drivers impaired by such combinations. Phentermine is similar to methamphetamine, but is less potent as a sympathomimetic amine. It is prescribed as an appetite suppressant and can be readily procured, even over the internet. It is not commonly associated with driver impairment and reports of detrimental effects on the operation of a motor vehicle are scant.

Specimens collected during DUID investigations were tested for ethanol by headspace gas chromatographic analysis and for amphetamine, methamphetamine, benzoyllecgonine, marijuana, opiates, benzodiazepine, methadone, phencyclidine, and barbiturates by an Elisa technique. Drugs, including methamphetamine and phentermine, were confirmed and quantified by gas chromatography / mass spectrometry after derivitization with heptafluorbutyric anhydride.

Of nine recent methamphetamine DUID cases, eight were found to be positive for additional drugs. Only one case was positive for methamphetamine alone while two contained five additional drugs. Alprazolam or marijuana was each present in five cases, cocaine in four, methylenedioxyamphetamine in three and ethanol in three. Eight of these drivers either crashed their vehicle or were unable to maintain a single lane of traffic. On-scene assessments by Drug Recognition Experts correctly identified central nervous stimulants in two cases; methamphetamine, cocaine, alprazolam in one case and ethanol cocaine and methamphetamine in the other. Four cases were classified as involving central nervous system depressant(s)

In another DUID case, phentermine in blood (0.25 mg/L) was combined with ethanol (0.13 g/dL), citalopram (0.1 mg/L) and zolpidem

(0.09 mg/L). The accused drove over a curb and onto a sidewalk and either failed, or was unable to perform, standard roadside sobriety tests. The driver later admitted to use of zolpidem to enhance the effects of ethanol. Phentermine use was acknowledged only as a diet aid. Anecdotal evidence from other cases suggests, however, that phentermine may modify, or intensify, the effects of ethanol.

This study indicates that methamphetamine-users very often abuse multiple drugs and that such combinations can result a serious impairment. Furthermore these combinations often complicate on-site classifications, even by a skilled assessor.

Phentermine is a seldom recognized agent that may modify, or enhance, responses to ethanol. Little data is available to make an assessment of its effects on driving, either alone or in combination. However, it is available, even over the internet and opportunities for abuse do exist. Phentermine may be worthy of greater scrutiny in DUID cases. Literature data indicates that levels in blood as high as 0.5 mg/L might be attained after repeated dosing.

Most importantly this presentation indicates that a complete toxicological assessment is essential for the correct classification of the methamphetamine impaired driver.

Phentermine, Methamphetamine, DUID



LW1 Old Remedies Are New: A Review of the Treatment and Death of King Herod

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After attending this presentation, attendees will gain an appreciation for investigating historical treatments.

This presentation will impact the forensic community and/or humanity by illuminating historical treatments in light of modern era science.

One of the most notable people to impress himself on the tablet of history is King Herod of Israel. Born about 73 (Before Current Era), he ruled as a vassal king of Rome from around 47 BCE until his death between 4 and 1 BCE.¹ He accomplished a great deal in his reign of nearly 40 years; some things were remembered for good, others for the misery he brought. One thing is clear, he lived a most self-indulgent life and he died a most uncomfortable death as documented in the writings of Josephus.^{1,2} Josephus is quite erudite in detailing what a keen first century observer can relate. There has long been a controversy as to the precise cause of death. There have been those that speculate he died from arteriosclerotic disease with kidney failure.² Some speculate diabetes; others have mentioned gonorrhea and still others suggest syphilis.^{2,3}

What Josephus tells us is that King Herod underwent a treatment of a special nature, one that was obviously not routine as to mention a routine treatment of the time would merit either simple mention or no mention at all.¹ To expound on the treatment and the side effects is to suggest that it was unusual for the time and would merit the attention of a king and his doctors. It would be the same as if a historian today mentioned that a historical figure received ampicillin for an earache as opposed to suggesting they went to a major medical center for experimental cancer treatment.

What was this treatment and could it shed light on the nature of the illness from which King Herod suffered? The treatment was described as "And here the physicians thought proper to bathe his whole body in warm oil, by letting down into a large vessel full of oil; whereupon his eyes failed him, and he came and went as if he was dying; and as a disturbance was then made by his servants, at their voice he revived again."¹ The treatment resulted in Herod's becoming distraught, disoriented and pained to the point his entourage suspended the treatment for fear of Herod's life.¹ He did recover for a while after this and showed some signs of improvement, enough that he was able to give a notable, coherent and moving speech.¹ This treatment would effectively elevate the core body temperature of the patient; depending on the duration of the immersion and the temperature of the bath, the temperature of the body could rise significantly.⁴ Though history is littered with ineffectual treatments given to prince and pauper alike, it must assumed that the treatment developed a reputation for healing the patients exposed to it; how else would it attract the attention of the King's people?

Of the named illnesses that could have afflicted King Herod which would have the greatest likelihood of showing response with such a treatment as this?

Humans have not evolved that much in 2000 years and atherosclerosis is not only a disease of modern, western society. It is a disease that afflicts mammals who have the profoundly fat laden diet of industrialized society. This could easily have been the case with King Herod as it is reported he was a very self-indulgent person and was

likely overweight.¹ The argument made by Hirschmann follows this reasoning to the conclusion that King Herod ultimately died of kidney failure. He says this as a result of the description of his "chronic low-grade fever, pedal edema, and abdominal pain. His condition deteriorates over several weeks with the appearance of shortness and foulness of breath, pruritus, convulsions of every limb, and gangrene of the genitalia," and diagnosing dementia on a vascular basis.³ Most of these could be equated with diffuse atherosclerotic disease. However, the resultant improvement from induced hyperthermia could not be connected and the symptoms during the course of the treatment could not strongly correlate. Though King Herod may have had kidney failure that would produce some of these symptoms, in view of the treatment and its results it is doubtful that atherosclerotic disease was the proximal cause for the kidney failure. Though gangrenous complications of atherosclerotic disease could cause fevers, without the gangrenous complications it is unlikely to cause any fevers at all. And if gangrenous complications that do cause fevers set in, then it is likely a pre-terminal event and not one that goes on for months. In truth, if atherosclerotic disease was responsible for the development of dementia, it would not square with the description penned by Josephus which outlines a case of paranoia with delusional thinking. As paranoid as King Herod was, he was in possession of his faculties enough to govern and speak effectively until very near death.¹

Is it possible diabetes mellitus was the cause of his death? It would come as no shock that somebody as indulgent as he was, likely overweight had diabetes, and that he would be more likely to develop Fournier's gangrene. However, to have the symptoms he had, as discussed above, in a diabetic person would be to imply that he had several of the complications of prolonged illness. He could have had pain from peripheral neuropathy. He could have had rotting flesh from gangrenous extremities. Fournier's gangrene is not a chronic situation, but acute in the extreme and does not extend over months.⁵ This is not the picture of chronic low grade fevers. He could have had breath that smelled fruity, had he been chronically ketotic. Kidney failure could have ensued from being a chronic diabetic and could have accelerated with superimposed atherosclerosis.⁶ The kidney failure would have added to his misery. None of this, however, would respond in any way to induced hyperthermia. Hyperthermia in the face of diabetic neuropathy would not have left him in any more pain than before the treatment. In fact, he would have appreciated it less due to the neuropathy.⁶ Insofar as diabetes mellitus is concerned, it is doubtful that this was the leading proximal cause of his organ failure and death. As with atherosclerosis, he may have suffered from some of its systemic effects around the time of his death, but it is difficult to fit with the transient recovery he had from the hyperthermic treatment.

It has also been said that King Herod died from the ravages of gonorrhea.⁷ What are the ravages of gonorrhea that could predispose him to multiple organ failure and yet be reversed by hyperthermia? The bacteremia could cause skin eruptions, joint pains, fevers and meningitis.⁸ None of this would comport with his prolonged paranoid behavior as it would have to cause bacterial meningitis; which would not stretch over years. Additionally, there is no evidence that hyperthermia has any impact on gonorrhea.

If it is likely that King Herod contracted gonorrhea, then it is just as likely that he contracted syphilis.² Certainly there was no ready treatment for it then as there was not a competent treatment until the early part of the 20th century. Left untreated, syphilis would affect every organ system and could easily result in kidney failure with the final

common pathway presentation Hirschmann discussed.^{3,9} As well, once neurosyphilis becomes an active issue, many psychiatric disorders can follow, including paranoia and delusional behavior.⁹ In the later stages, gummas develop in the integument and the intestines.⁹ Painful peripheral neuropathy is common in late stage syphilis as is cardiopulmonary involvement with respiratory symptoms.⁹ What is more curious about this possibility and suggests it was the proximal cause of his death is the response to the hyperthermic treatment. Of the suggested maladies, this is the only one that has a documented connection between disease, treatment, and side effects that could well correlate. In 1927 the Nobel Prize for Medicine was awarded to Dr. Wagner-Juragg for his discovery that neurosyphilis could be treated with iatrogenically induced malaria.¹⁰ The intermittent high fevers were apparently sufficient to kill off the resident treponemes. One of the side effects was the discomfiting development of the Jarisch-Herxheimer reaction in response to the massive disgorgement of treponeme membrane protein into the circulation.¹¹ As described, in the current medical literature, this could have been the reaction King Herod had to his hyperthermic treatment as described by Josephus.¹ As King Herod was not allowed by his entourage to complete the treatment, it was not totally successful, but did give him a reprieve for a short while. This view of the circumstances surrounding the declining health and demise of King Herod is parallel to the suggestions of Dr. Hirschmann in that he could have died imminently from kidney failure; however the cause of the kidney failure was likely syphilis.

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Herod , Neurosyphilis, Hyperthermia

LW2 The Servant Girl Annihilator of Austin, Texas: A 19th Century Serial Killer

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The goal of this presentation is to inform the forensic community of a little-known, but noteworthy historical case.

This presentation will impact the forensic community and/or humanity by presenting a nineteenth century serial killer whose crimes transcended racial and class line.

Two decades after the end of the Civil War, a serial killer known as the Servant Girl Annihilator stalked Austin, Texas. Using an ax to bludgeon and mutilate his victims before sexually assaulting them, the Servant Girl Annihilator killed seven women between New Year's Eve 1884 and Christmas Eve 1885.

Mollie Smith, a twenty-five year old African-American, was the first victim. She was found behind the home where she worked as a live-in cook and maid. Her face was badly disfigured and there were injuries to her head from a blood-stained ax found inside the house. Her nightgown was shredded and her body posed in a manner that suggested sexual assault. Mollie's common-law husband, Walter Spencer, had also been attacked that night. Walter suffered a single gash to the face, presumably from the same ax that had killed Mollie. Although Walter could give no account of what took place, the blood splatters and disarray of the room he and Mollie shared indicated that the killer had attacked the couple while they were in bed. Then, with Walter unconscious, the killer dragged Mollie outside. Mollie's former lover, William Brooks, was arrested for the crime, but released a few days later for lack of evidence.

Almost six months passed before the next murder. On May 6, 1885, Eliza Shelley, a thirty year old African-American cook, was found with her skull cleaved by an ax and punctures to her head. She, too, was posed in a manner that suggested she was sexually assaulted. Eliza, along with her three children, lived in a small cabin behind the residence where she worked. Bloodstains on the pillows and a man's footprints leading to and away from the cabin indicated that Eliza was attacked in bed and then taken outside. Two men were arrested, but each was soon let go.

Irene Cross was the next victim, on May 23, 1885. She, too, was an African-American, who was employed as a servant girl. In contrast to the first two victims, she was attacked with a knife. Irene lived long enough to speak to reporters, but could offer no useful details. The killer struck again in late August 1885 attacking Rebecca Ramey, another African-American servant girl and her eleven year old daughter, Mary. Rebecca was knocked unconscious, while Mary was dragged outside, assaulted, and then stabbed through both ears with an iron rod. Neither Rebecca nor Mary, who survived for a time after the attack, could provide any description of their assailant.

The night of September 26, 1885 saw four new victims. That night Lucinda Boddy, an African-American cook, went to stay with her friend Gracie Vance. Gracie lived with her common law husband, Orange Washington, in the servant's cabin behind the home of her employer. A fourth person, Patsie Gibson, may also have stayed that night in the cabin. After the four had gone to sleep, Gracie was awakened by someone grabbing her. Her screams awakened Orange, who was at once knocked unconscious by a blow from an ax. The intruder then attacked Lucinda and Patsie striking them in the head and face with the ax. Before losing consciousness, Lucinda was sexually assaulted. The attacker then dragged Gracie out of the cabin into some nearby bushes where she, too, was sexually assaulted and then finished with a blow to the skull from a brick. Meanwhile, Lucinda had regained consciousness and aided by a kerosene lantern began looking around the cabin. She found Orange on the floor and then saw another man who told her not to

look at him. Throwing the lantern at him, Lucinda ran from the cabin to get help. No one was caught, although a bloody ax was found in the cabin and a blood-stained brick near Gracie's body. Orange Washington died the following day. Eventually, Walter Spencer, the common law husband of the first victim, Mollie Smith, was arrested and tried for the crimes, but acquitted.

The Servant Girl Annihilator struck for the final time on Christmas Eve, 1885. Up to that time all of his victims had been African-Americans who worked as servants. His last two victims, Sue Hancock and Eula Phillips, were however, both Caucasian and both well-to-do members of Austin's social elite. Sue was found in the backyard of her home. She had been dragged from her bed, struck repeatedly with an ax, and sexually assaulted. Similarly, Eula had been dragged from her bed, beaten with an ax, and left in an alley near her home. As with several of the other victims her body had been posed in a way that suggested sexual assault. Eula's husband, Jimmy, had been struck in the back of the head and left unconscious in the couple's bed. A bloodstained ax lay on the floor and a trail of blood led to the spot where Eula's body was found. On the porch was a man's bloody footprint. Within a few days police arrested the husband of each victim for the murder of his wife.

As the police discovered, Moses Hancock was an alcoholic whose excesses had led Sue to write a letter in which she considered leaving him. When Moses found the letter — so the police theory went — he killed Sue in a drunken rage and staged the crime scene to mimic the earlier murders. The case went to trial, but the jury was unable to reach a verdict and Moses was never retried. The marriage of Jimmy and Eula Phillips provided even more lurid details. Their marriage was an unhappy one. Jimmy had threatened Eula with a knife and thrown things at her. Eula was apparently having a love affair at the time of her murder. At trial, prosecutors argued that Jimmy had killed Eula in retaliation for the affair, then arranged the crime scene and even injured himself to copy the servant girl murders. Despite a shoe size that was far too small to match the bloody footprint found at the scene, Jimmy was convicted of second degree murder. A Texas appeals court quickly overturned the verdict.

The Servant Girl Annihilator was never caught. In all, he killed seven women using an ax on all but one. His first five victims were African American servant girls; his last two were Caucasian society belles. There were also six collateral victims injured during the commission of the crimes including Orange Washington, who died from his wounds. Six men were arrested for one or another of the murders. Three were tried and one was convicted. Some contemporary sources suggested that the crimes were the work of a two men working together. Others have suggested that the Servant Girl Annihilator and Jack the Ripper were one and the same. This theory is based on a Malaysian cook named "Maurice," who worked at the Pearl House hotel in Austin in 1885, near where several of the victims lived. "Maurice" left Austin in January 1886 only to resurface in London in 1888 at the time of the Ripper murders. While in London, he had threatened to kill Whitechapel prostitutes before disappearing once again.

One legacy of the murders can still be seen in Austin to this day and it is on the National Register of Historic Places. Austin's "moonlight towers," the one hundred fifty foot tall arc lights that watch over several of Austin's older neighborhoods are still standing — more than a century after they were first erected to extinguish the darkness in which the Servant Girl Annihilator struck.

Serial Killers, Ax Murders, Jack the Ripper

LW3 The Last Word: The Haymarket Affair — When Politics Explode

David Weinberg, JD, Thematrix Group, 3 Taliar Ridge Road, Guilford, CT 06437*

Chicago's Haymarket Affair of 1886 will be used as a case study on the impact of political language, threats, and violence upon American law enforcement and criminal justice. After attending this presentation, attendees will become familiar with the globe bombs and pipe bombs advocated by the anarchist press, and the social, political, and economic forces that led to this advocacy.

This presentation will impact the forensic community and/or humanity by examining the impact of popular politics on constitutional freedoms and the processes of criminal investigation and trial in a controversial case of political violence, so that historical lessons can be applied objectively to politically charged investigations and trials today.

On May 1, 1886, labor organizations throughout the United States organized a national walkout in support of an eight-hour day for American workers. Chicago civic leaders purchased a Gatling gun and 2,000 rounds of ammunition to prepare for the occasion. Tensions and rhetoric ran high, but the violence that leading industrialists had predicted failed to materialize. On May 3, 1886, German-born newspaper editor August Spies was addressing a pro-labor gathering when Chicago police rushed strikers at the nearby McCormick Reaper plant, killing two workers. The following day, Spies reported on the incident in his paper, the *Arbeiter Zeitung*. That evening he helped organize a rally in Haymarket Square to protest the previous day's killings.

Mayor Carter Harrison, a relative of two American presidents, attended the rally hoping that his presence would avoid violence, making sure he was recognized by his trademark slouch hat and lit cigar. Harrison and much of the crowd left as bad weather threatened. When police squadrons with drawn pistols attempted to disperse the remaining protesters, someone threw a bomb into their ranks, killing Officer Matthias Degan. Police opened fire into the crowd and at each other, and seven more officers and an unknown number of civilians died in the aftermath. This presentation will examine the bomb site, witness descriptions and evidence found at the scene.

From May 5th to May 6th, police arrested about 2,000 Chicago men and women, but the bomber was never identified. On May 27th, Spies and seven other anarchist organizers, speakers and writers were indicted for the murder of Officer Degan. A special bailiff managing jury selection declared publicly, "These fellows will hang as certain as death."

The trial began on July 16th, 1886, Captain William Black, a Civil War hero, defended the men against his wife's wishes and at the cost of his legal career. Trial evidence featured an unarmed globe bomb seized from *Arbeiter-Zeitung* offices, and a variety of pipe bombs which police found under a sidewalk, with no demonstrated connection to any defendant. On August 19th, 1886, the jury convicted all eight defendants. Illinois Governor Richard Oglesby pardoned two defendants. One died in prison when a blasting cap exploded in his mouth. The other four, including Spies, were hanged on November 11, 1886. On June 26, 1893, Governor John P. Altgeld granted full pardons to all the defendants, wrecking his political future.

Monuments commemorating the defendants have been erected at the site of the Haymarket rally and at Waldheim Cemetery, where seven of them are buried. A 9 foot bronze monument to the police officers previously stood near the rally site. In 1927, on the 31st anniversary of the Haymarket rally, a streetcar jumped its tracks and knocked the statue off its pedestal. The Weather Underground movement was credited with blowing the statue off its pedestal in two successive years, 1969 and 1970. It stands today at the Chicago Police and Fire Academy.

Bombs, Investigations, Prosecution

LW4 The Haymarket Bombing: Questioned Document and Related Testimony

Duayne J. Dillon, DCrim, Document Services, Court Station, PO Box 488, Martinez, CA 94553*

After attending this presentation, attendees will learn about the history of handwriting identification in a famous 1880's criminal case and of the American questioned document examiner who was credited with having the first case as a handwriting expert.

This presentation will impact the forensic community and/or humanity by broadening historical information regarding American forensic science.

The Haymarket Bombing occurred in Chicago on 4 May 1886. A Chicago police captain backed by 180 officers ordered over 3,000 people assembled at a labor rally in Haymarket Square to "disperse immediately and peaceably." A bomb was thrown into police ranks resulting in the killing and wounding a number of police personnel. Immediately the police fired on the crowd and also apparently received fire from members of the assembly. The exact number of dead was not determined although eight police officers were killed and sixty-seven were wounded and it was estimated that over 200 members of the crowd were injured. This presenter initially became interested in this case because of the reported involvement in the examination of evidence by an early California questioned document examiner, Theodore Kytka.

Kytka, an Austrian, was born on 22 March, 1863. He attended Technical and Art School in Vienna until 1883, served in the Austrian army, traveled in Northern Europe and in 1884 immigrated to the United States. He subsequently went to Chicago where he became connected with the Chicago Herald newspaper. It has been claimed, that that following the Haymarket incident, he examined the writings of many of the individuals arrested in connection with the bombing and identified some of the questioned writing as that of August Spies one of the individual subsequently tried convicted and executed for his participation in the bombing.

This was Kytka's first case as "expert on handwriting," a work that was claimed to have subsequently made him famous and "renowned through the world." This presenter has for many years assembled published articles by Kytka, correspondence, and other information regarding his career in California. Only recently has information been located that illuminates the use of questioned documents in the Haymarket case.

History, Identification, Kytka

LW5 The Saga of Willie Bryant's Winchester

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After attending this presentation, attendees will have gained understanding of some of the means and techniques used to reconstruct "cold case" homicides, and develop further appreciation of the critical importance of ethical conduct in forensic examinations and the criminal justice system.

This presentation will impact the forensic community and/or humanity by illuminating the human tragedy that results when ethical and legal standards are subverted, as well as exploring the role of historical forensics in a modern cold case homicide investigation.

In October 1925, 21-one-year old Henry Sweet was found shot to death in the rural northern California mountains. His 17-year-old female hunting companion, Carmen Wagner, was missing, along with the two Winchester rifles they carried. A posse searching for Wagner found her rifle a week after her disappearance. It had mysteriously re-appeared at the scene of the crime. Her body was subsequently found in a nearby canyon; she had been shot to death. The sensational media of the period reported the crimes nationwide, dubbing them the Coyote Flat Murders.

Jack Ryan, a Native American, was arrested for the killings. The physical evidence in the case was examined by famed American criminalist Edward Oscar Heinrich. Following a trial marked by perjury, planted evidence, and politics, Ryan was acquitted of the charge of murdering Wagner. A newly elected district attorney, Stephen Metzler, focused his attention on a Winchester rifle in the possession of Willie Leslie Bryant, but purportedly identified as Sweet's missing weapon. Metzler was no stranger to crime himself as he operated an illegal bootlegging ring out of the district attorney's office.

Bryant maintained the rifle, a composite weapon made up of parts from two older Winchesters, was his. He was indicted by the grand jury for perjury and endured three separate de-facto murder trials, each ending in a hung jury before charges were finally dismissed in the spring of 1928. Prosecutorial misconduct, lost evidence, and jury tampering characterized these events. Each trial was significantly more forensically detailed, involving metallurgy, tool mark identification, and Winchester manufacturing practices at the beginning of the 20th century. Heinrich testified in the third trial, debunking the prosecutor's evidence.

Shortly after the charges against Bryant were dismissed, Ryan was arrested and charged with sexual assaulting three young girls. Finally, after several months in jail and an all night third-degree interrogation session, he "confessed" to the murder of Sweet, fearing he otherwise would be killed. Ryan pled guilty and was sentenced to life in prison. En route to the penitentiary, Ryan supposedly guided authorities to where he had hidden Sweet's missing Winchester. Forensic examination, however, revealed it was planted shortly before being "found."

Imprisoned for the next 26 years, Ryan steadfastly maintained his innocence. Federal and state investigations in 1948 and 1951 cast doubt on the credibility of his conviction. Attention again focused on the Bryant rifle, which Metzler had kept in his possession. Pre-death statements by a case principal re-activated the case in the 1980s. The detailed testimony and events surrounding Bryant's rifle, its composite nature, and the manufacturing history of Sweet's original Winchester provided key information supporting Ryan's innocence in the Coyote Flat Murders. Heinrich's original case notes and diagrams were found and reviewed, and the court exhibit Winchester used by Bryant's defense attorney was discovered. Winchester archival records, not available in 1927, confirmed Bryant's descriptions of the original guns, and validated his innocence. In 1996, Ryan was granted a posthumous pardon.

Cold Case Homicide, Heinrich, Winchester

LW6 The Lincoln Target Board

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After attending this presentation, attendees will learn of a pivotal ballistic moment in American History.

This presentation will impact the forensic community and/or humanity by describing a little known historic moment examined with modern techniques.

In August of 1863 (nearly 2½ years into the Civil War) Christopher Spencer had a private meeting with President Abraham Lincoln where he presented his revolutionary 7-shot repeating rifle to the President. Prior to this meeting, both Union and Confederate soldiers had fought with paper cartridge/muzzle loading firearms. The day after his meeting with the young inventor, Lincoln fired a full magazine from a Spencer rifle at an improvised target fashioned from a pine board. Lincoln was so impressed with the Spencer that he personally endorsing it and set aside General James Ripley's opposition to the purchase of repeating cartridge guns for the Union Army. The Spencer rifles and carbines became the most dreaded and hated gun by the Confederates who fought the entire war with single shot muzzle-loading rifles and muskets.

Spencer retained the target board for many years then sent it to the State of Illinois where it purportedly was lost in the mist of time.

The Lincoln target board has been found and the author was recently allowed to personally examine and photograph it at the Illinois State Military Museum in his home town of Springfield, Illinois.

The Lincoln target board allows the viewer to see what sort of marksman the 16th president was but past examinations of the bullet holes in this most famous of all targets have raised some question as to just what version of the Spencer rifle President Lincoln fired on that historic and fateful day in August 1863. Was the rifle presented to President Lincoln really a .56-.56 production rifle or some custom chamber in an earlier caliber of either .38 rimfire or .44 rimfire?

Firearms knowledge and the previous examination of a great variety and number of bullet holes in wood allowed this question to be answered.

Lincoln, Spencer, Ballistics

LW7 Bladensburg: Congressional Dueling Ground of the 19th Century

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After attending this presentation, attendees will understand the origins of dueling, reasons for participation by U.S. Congressional representatives, and the circumstances of certain duels fought near the District of Columbia boundary at Bladensburg, MD.

This presentation will impact the forensic community and/or humanity by demonstrating how the practice of dueling by Congressmen contributed to the decline of dueling in the United States.

Dueling, historically a legal avenue of dispute resolution, evolved into an extrajudicial practice to determine issues of honor, and included U.S. Congressional representatives among its practitioners; the dueling venue at Bladensburg, MD, saw many duels in the first half of the 19th century, during which time legal and social pressures brought about by Congressional participation hastened the decline of the practice in the United States.

The duel originally was a legal method of resolving disputes. The earliest laws governing “judicial duels,” as these legal duels were known, date from the 6th century in Europe. Distinguishing it from other varieties of combat, the duel is prearranged, fought between two persons with deadly weapons according to an accepted code of procedure, and settles a private quarrel. Among the leading dueling countries were Italy, France, Germany, Britain, and later the United States.

Over time, legal and religious opposition to dueling increased, and the judicial duel disappeared. Dueling survived as an illegal activity practiced chiefly by the aristocracy to decide private matters of honor, and was governed by various dueling codes. In the United States, with no titled aristocracy, it was a practice of lawyers, government officeholders, and sundry gentlemen, most frequently in the Southern states, and usually governed by the *Code Duello*.

Representatives in the United States Congress periodically participated in duels. The Bladensburg dueling ground, a half-mile past the District of Columbia line in Maryland, was the preferred venue, earning the name “The Congressional Dueling Ground,” and was said to be the most popular dueling ground in America. Over fifty duels were fought there, and the early 19th century was its most active era. Not all Bladensburg duelists were Members of Congress (famous duels fought there by non-Congressmen include the Decatur-Barron, Mason-McCarty, and Key-Sherborne duels) but many were. Two engagements illustrative of Congressional encounters are the Jackson-Pearson duel of 1809 and the Cilley-Graves duel of 1838.

Both the Jackson-Pearson and the Cilley-Graves duels arose from remarks made on the floor of the House of Representatives which resulted in challenges and acceptances to duel. The Jackson-Pearson duel resulted in wounding but no fatality; Rep. Cilley was killed in his duel with Graves. A 1796 House resolution providing for expulsion of any Member engaging in a duel while Congress was in session went unheeded in the case of the Jackson-Pearson duel; a motion referring the infraction of the resolution by these two Members to the Rules Committee was tabled. But twenty-nine years later, as public sentiment against dueling escalated, Cilley’s death resulted in a Congressional investigation, expulsion of Rep. Graves from Congress, and passage the following year (1839) of a District of Columbia law forbidding dueling.

Although dueling did not expire with the passage of this law, its decline was hastened; the social acceptability of dueling waned, and with legal support, by the end of the Civil War the practice was all but extinct in the United States.

Duel, Bladensburg Dueling Ground, Congressmen

LW8 Casimir Pulaski: A Case of Questioned Identity

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After attending this presentation, attendees will find that they look at routine sex determination of skeletal remains from a more critical perspective. This appealing historical case highlights the problem of gender assignment and identification. It alerts the identification scientist to the wide range of sexual presentations confounding easy male/female recognition. Attendees will have examples of specific syndromes to consider.

This presentation will impact the forensic community and/or humanity by demonstrating the problems created by ambiguous genitalia and gender misidentification and the symptoms of congenital adrenal hyperplasia.

It is reasonably well known that determination of sex from skeletal remains is population dependent and sometimes ambiguous. But even the seemingly unambiguous cases can be confounded by life styles or congenital anomalies.

Casimir Pulaski was a Polish nobleman and an accomplished equestrian, trained in the finest of European military traditions. He was known to be adventurous, reckless, and yet reclusive. In 1768, he began his command of Polish forces in the fight for independence from Russia. After being condemned to death for his efforts, he fled to France where he was recruited for the cause of American independence. Pulaski became the first U.S. Calvary Commander. His troops were brilliantly successful until the Battle of Savannah in 1779. Pulaski was wounded by grapeshot “to the groin,” and died two days later on a hospital ship anchored in the Wilmington River. He was reported to be buried on a nearby plantation. In 1853 the purported remains were exhumed, and examined at the Medical College of Georgia, where they were declared to be those of Pulaski. The skeleton was packed in a metal box and placed within the plinth of the Pulaski Monument in Savannah. In 1996, the monument was dismantled for renovation, and the local coroner decided it was time to validate the 1853 identification.

The skeletal analysis was standard. It was obvious by modern osteological methods that the remains were those of a woman, and therefore presumably not those of Pulaski. But the result itself required further validation, and the subsequent investigation exposed a number of ambiguities. Not only were the remains consistent with Pulaski in age, race, and stature, but also in two instances of specific antemortem trauma – a broken hand and a battle wound to the face. (There was no

reported perimortem trauma to the bone.) Drawings from life (as opposed to long-postmortem paintings of a dead hero) show a smoothly rounded face with a pointed chin and a small body. And, possibly most significant, historical documents revealed unusual circumstances surrounding his birth and life.

The identification committee was driven to consider the possibility that this might actually be Pulaski. If so, the “typical” female pelvis is an extreme outlier of a male phenotype, or Pulaski was a male by gender only and not by genotype. Gender misassignment became a new focus of investigation. Anomalous genitalia, occurring in approximately four births per 1000, are the main reason for gender misassignment. Masculinization of female genitalia is most frequently due to congenital adrenal hyperplasia, with an approximate occurrence rate of 1 in 12,000 female births.

The remains found in Pulaski’s monument are probably from a biological female, but there is reason to believe that they may be the remains of a famous person whose gender was misassigned at birth. Genetic analysis may someday put this mystery to rest. Comparative mtDNA has been located, but analysis of the monument remains has not yet yielded a useful sample.

Sex Determination, Ambiguous Genitalia, Gender Assignment

LW9 The Crash of the USS Macon

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The goal of this presentation is to discuss the root cause of the crash of the USS Macon that resulted in the loss of the airship and the end of the American lighter-than-air aircraft program.

This presentation will impact the forensic community and/or humanity by examining the crash of the USS Macon from a modern forensic engineering perspective.

The world’s largest aircraft crashed on the evening of February 12, 1935, off the coast of Point Sur, California. The USS Macon was an aluminum alloy-framed, lighter-than-air dirigible. It was three times longer than a Boeing 747 with a structure weighing more than 120 tons. This mass was kept airborne by over 6 million cubic feet of helium contained within cells inside the hull. The Macon was built in the Goodyear-Zeppelin plant in Akron, Ohio, in 1933. Its mission was to scout over ocean waters. To this purpose, it carried four Curtiss F9C Sparrowhawk fighters that it could launch, retrieve, and refuel. It was referred to as the “floating aircraft carrier in the sky.”

On the evening of February 12, a gust of wind collapsed its upper tail fin, ripping holes in three of its helium filled cells. Some of the tail fin supports apparently had been removed to streamline the Macon and to increase its nominal top speed of 80 mph. The Macon hit the water tail first and floated long enough for all but two of its crew of 83 to escape and be rescued by passing ships. One of the fatalities jumped from the falling ship and the other was lost trying to retrieve his belongings. The loss of the Macon ended the military interest in such structurally vulnerable, lighter-than-air air craft.

Recently, the wreck sites of the Macon, as well as the four Sparrowhawk aircraft, have been located by a NOAA team, using sidescan sonar survey techniques. An expedition, utilizing a remotely operated submarine vehicle to conduct a systematic visual survey, is scheduled for this year.

USS Macon, Dirigible, Failure Analysis

LW10 When Experts Disagree: Part II – Can You Have Too Many Experts?

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The goal of this presentation is to outline a complex and convoluted story showing that expert witness affidavits and testimonies may confuse rather than expedite the process of adjudication.

This presentation will impact the forensic community and/or humanity by using a case study to raise awareness of the possible problems and confusions that may arise when too many expert witnesses provide inconsistent testimonies.

In 2004, the retrial date had been set, even though the defendant had already been convicted once of this murder. The State of Ohio was the plaintiff and Larry Schlee was the defendant. More than a decade before (1993), the courts proved that the defendant shot and killed the victim, Frank Carroll, less than a year after Carroll tried to kill Schlee and got shot in the face himself. Frank Carroll was shot fatally, point-blank in the face in 1980 in a park in Lake County, Ohio, in the presence of a witness. Schlee eventually wrapped the body in plastic bags, placed the victim in a sleeping bag, and disposed of the body two states away, dumping the victim’s car in the opposite direction.

Why would Judge Lucci decide for a retrial of what appears to be cut-and-dried homicide proceedings, occurring over a decade before, for a crime almost 25 years old? It boils down to a single conflict: *so many experts, so little concurring evidence.*

The Story: In 1981, decomposed remains were found in a sleeping bag in Chautauqua County, N.Y. Examination by the Buffalo Medical Examiner found an adult human skeleton with what appeared to be gunshot wounds (GSWs) to the face. This case came to be known as “Frank in the Bag.” The victim remained unidentified for years, but the remains in the sleeping bag came with a belt inscribed with ‘Frank’ on the back. The forensic anthropology component of this case began in 1981 when Dr. Wilton M. Krogman (one of the “Founding Fathers” of forensic anthropology) was asked to examine the remains.

Krogman’s facial reconstruction and skeletal analysis indicated that this was a White male, 35-40, approximately 5’ 7¼”. Additional comments included:

[There was] an unhealed (recent) injury which exposes the cancellous composition of the upper orbital margin and the frontal bone above it. At first I thought it had been caused by a knife-slash, but I think it may have been caused by the glancing impact of a bullet.

This single statement probably stimulated repeated examinations of the facial bones by numerous examiners, and unfortunately biased many with preconceived notions of horrific trauma as opposed to postmortem rodent gnawing. The first to follow Krogman was an anthropology student from Buffalo who sectioned a piece of zygomatic bone to submit to SEM and chemical testing, hoping for residual metal from a knife. The second and third were a chief medical examiner and a well-known paleoanthropologist from a nearby metropolitan area.

In 1991, when the eyewitness finally went to the authorities to confess what she had seen, the prosecution had everything they needed: an eyewitness, identification of “Frank in the Bag,” and a homicide ruling with the cause of death listed as GSWs to the face by the Buffalo ME. The prosecution also got something they did not need; experts confusing the injuries and classifying them into a mixed bag of

horrendous afflictions to a human body. One set of experts, the pathologist and paleoanthropologist, submitted a report to the prosecution on the first day of the trial in 1993. Among other things, this report stated that the GSWs to the face were non-lethal, but stab wounds (“*Perimortal mutilations by edged instrumentality*”) to the neck vertebrae were. This was described as evidence of the worst case of torture either had ever seen (the defects to the brow mentioned by Krogman). Needless to say, these scenarios muddied the prosecutorial waters, and interestingly enough, this evidence was never submitted to the court. The defendant, Schlee, was convicted and sentenced to life imprisonment.

In 1997, the defendant began to research the evidence himself. He knew of the report by the pathologist and paleoanthropologist that talked about non-lethal GSWs to the face and lethal sharp force trauma to the neck. After a second report from these experts, he added another substantiating anthropologist and a biomechanist to refute the eyewitness account. This last expert even based many of his findings of innocence on handedness and bullet trajectory.

The Retrial Decision: Judge Lucci was inundated with experts. The experts mentioned above appeared to be opposed to the prosecution’s witnesses. The judge commented that there was no way to tell which experts were accurate and which were not, so it was decided to go to trial and let the jury decide.

This presentation is the second in a series (Saul, Saul, and Symes 2005) and outlines a complex and convoluted story of expert witness affidavits and testimonies that span a quarter century on a single case. These accounts were presented in the retrial to a jury whose job it was, in this case, to sort out the opinions of opposing experts.

The Moral of the Story: The following list is offered and may indicate *too many experts* and help the forensic expert to guard against “forensic babble:”

1. Elaborate, non-conventional terminology
 - “*Perimortal mutilations by edged instrumentality*”
2. Unwarranted information
 - Don’t build off other experts — build your own case
 - Determination of ballistic direction inside of the body when there is no soft tissue or adequate bone damage to track a bullet
 - Determination of ballistic direction outside the body — not possible unless you have exceptional evidence documentation
3. Unethical “scientific” testing
 - E.g. attempting to push a bullet through an existing bone wound!
4. Scientific testing designed to look sophisticated: Science for the sake of Science.
 - E.g. scanning Electron Microscopy only for the sake of SEM
5. Estimation of handedness.
 - No one does that anymore!! (And besides, who cares!!)
6. *Specifically timed* taphonomic or perimortem traumatic influences
 - Usually an indication of overstatement
7. Far-fetched scenarios
 - E.g. Torture estimations based on taphonomic ignorance, too little evidence, too many types of trauma, exotic scenarios, too many variables, etc.

Reference:

¹ Saul, Julie M., and Frank P. Saul and Steven A. Symes 2005 When experts disagree: There may be a rodent involved – Part I: The Request for a new trial. Poster (H25) presented at the 57th Annual Meeting of the American Academy of Forensic Sciences, New Orleans, LA.

Expert Witness, Perimortem Trauma, Rodent Gnawing



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