Professional Review and Commentary[a]

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[a]The views expressed are those of the authors and do not necessarily reflect the view, the position, or the policy of *Forensic Science Review* or members of its editorial board.

Forensic Science Review's Professional Review and Commentary section highlights contemporary issues and events in the profession of forensic science. To contribute updates or commentary or to recommend books for review, please contact Mike Baylor (mbaylor@nc.rr.com), Jeff Teitelbaum (Jeff.Teitelbaum@wsp.wa.gov), or Ray Liu (rayliu@uab.edu).

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News and Recent Developments

The Forensic Science System of Lithuania

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As in most countries, forensic activities are rather specific and therefore they require separate legal regulations. Forensic activities differ from other spheres of human activities because they are initiated only by judges and courts. As such, they are applied only in court (justice) proceedings in judging administrative, criminal, and civil cases. In this way, forensic examination is distinguished from other expert activities that are not related to court procedures. Therefore, every national legal system must choose how and in what ways these activities are performed.

Institutions and Regulations. In Lithuania, forensic examinations are performed mainly by state forensic institutions; they are:

- Forensic Science Centre of Lithuania by the Ministry of Justice (FSCL),
- Forensic Science Centre of Lithuanian Police acting by the Ministry of Interior (LPFSC),
- State Service of Forensic Medicine by the Ministry of Health (SSFM), and
- State Service of Forensic Psychiatry by the Ministry of Health (SSFP).

All state forensic institutions act in three different spheres: Performance of forensic examinations; research and methodical work; and training of experts and recognition of qualifications.

All forensic institutions have broad collaborative relations with Lithuanian and foreign forensic institutions. For example, FSCL and LPFSC are members of the European Network of Forensic Science Institution (ENFSI) and since 2008, a member of the Baltic States Forensic Institution Association. LPFSC, FSCL, and SSFM are certified according to LST EN ISO/IEC 17025 standard. Principles and rules of performance of forensic examinations are defined by procedural laws of the Republic of Lithuania and by the special Law on Forensic Examination (LFE) [1], valid since 2003. Lithuanian LFE regulates the following:

- The order of including forensic experts into the registrar;
- The basis for suspending of forensic activities or withdrawal of forensic expert from the registrar;
- The functions of council of coordination of forensic activities; and
- The limits of usage of special knowledge and other.

All these rulings are detailed in other legal norms, which include: the orders of Minister of Justice of the Republic of Lithuania (minimum legal knowledge of forensic experts; the order of issuance of forensic expert certificate, etc.) [2]; the regulations of performance of forensic examination in state forensic institutions [3]; the recommendations of the Prosecutor General of the Republic of Lithuania on ordering forensic examination [4], and the Code of Ethics of forensic experts obligatory for all registered forensic experts [5].

The LFE defines a state forensic institution as any governmental institution whose main activity is performance of forensic examinations. State forensic institutions may be established by the Government or Ministries of the Republic of Lithuania.

State forensic institutions have some obligations under procedural laws. Procedural laws define that the forensic examination may be appointed to the forensic institution [6]. Such regulation creates additional obligations for the management of forensic institutions, chief among which is to choose competent and qualified forensic experts for the performance of examinations, as well as properly organize and control the performance of ordered forensic examinations. It should be noted that all experts employed by a state forensic institution performing court-ordered forensic examinations should be included in the registrar of forensic experts.

Under the LFE, forensic examinations may be performed by private forensic experts, who have certificates of forensic expertise and are included in the registrar but do not work in any state forensic institution. Another institution responsible for coordinating forensic activities under LFE is the Council of Coordination of Forensic Activities. It is a collegial, public nonprofit body that

- Gives proposals for the Minister of Justice for legal development in forensic science:
- Hears and decides claims on possible breaches of the Code of Ethics of forensic experts;
- Coordinates activities of state forensic institutions and registered forensic experts;
- Approves list of types of forensic examinations; and
- Regulates interests of forensic institutions, law enforcement institutions, and other institutions related to the forensic area.

The other legal institute playing an important role in the forensic system is the registrar of forensic experts of Lithuania, which defines the areas of forensic examination and subjects performing examinations. The registrar consists of state and private forensic experts. State forensic experts constitute about 80% of the registrar and private experts mainly cover three forensic areas — namely, audit, construction examination, and evaluation of property.

The Ministry of Justice has the broadest rights in the sphere of regulation of forensic activities. It develops the politics of forensic science of Lithuania as well as performs the legal regulation of forensic science (adoption of legal norms related to the usage of special knowledge in the proceedings, etc). Also, it is responsible for the management of the registrar of forensic experts, inasmuch as only the Minister of Justice can include a person into the registrar or withdraw him/her from it. The oath of forensic expert is also given to the Minister of Justice.

Forensic Scientist. The requirements for individuals intending to become forensic experts are defined in the LFE and are as follows:

- To have university education in the sphere most suitable for a chosen type of forensic examination;
- To pass/take the exam on special knowledge and minimum legal knowledge for obtaining certificate of forensic expert; and
- To be of irreproachable character and without any recorded conviction for severe crimes or crimes against justice, state office.

Persons who comply with these requirements are included into the registrar, which is administrated by the Ministry of Justice. Currently there are 377 registered forensic experts in the registrar [7].

All these national regulations are mostly in compliance with EU requirements for forensic activities defined mainly in two documents — Council Framework Decision 2009/905/JHA of 30 November 2009 "on Accreditation of forensic service providers carrying out laboratory activities" [8] and European Commission for the Efficiency of Justice (CEPEJ) Guidelines on the role of court-appointed experts in judicial proceedings of Council of Europe's Member States Document adopted by CEPEJ at its 24th Plenary Meeting (Strasbourg, Germany; 11–12 December 2014) [9], which defines minimum requirements for a forensic expert, general principles of ordering and performing a forensic examination, and limits of the role of forensic expert in the court.

REFERENCES

1. Not all countries in the world have specific laws intended to regulate special legal institutes addressing forensic examination. Nevertheless, some countries adopted laws expressing the importance of such legal institutes for their justice system. For example, in the Czech Republic, the law on forensic experts and interpreters exists since it was adopted in 1967. In France it has existed since 1971; Austria since 1975; Ukraine since 1994, and Russia since 2001. Lithuanian law may be found at *https://www.e-tar.lt/portal/lt/legalAct/TAR.286DC4AF9827*.
2. *http://www.tm.lt/teisineinfo/teisesaktas/9*.
3. More details can be found in *http://www.ltec.lt/ekspertiziu-atlikimo-nuostatai*; *http://ktc.policija.lt/lt/teisine_informacija/isakymai/policijos_generalinio_komisaro_isakymai_kriminalistiniai_tyrimai.html*; *http://www.vtmt.lt/pages/lt/teisine-informacija/teises-aktai/lietuvos-respublikos-sveikatos-apsaugos-ministro-isakymai.php*; *http://www.vtpt.lt/lt/teisine_informacija/darymo_nuostatai.html*.
4. *http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=476569&p_tr2=2*.
5. *https://www.e-tar.lt/portal/legalAct.html?documentId=944af830a82e11e38e1082d04585b3dd*.
6. CrPC article 209; CiPC article 212.
7. *http://www.tm.lt/dok/teismo-ekspertai/2015%2010%2030%20TEISMO%20EKSPERTU%20SARASAS.pdf*.
8. *http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009F0905*.
9. *https://wcd.coe.int/ViewDoc.jsp?Ref=CEPEJ(2014)14&Language=lanEnglish&_Ver=original&BackCoorDBDCF2&BackColorIntranet=FDC864&BackColorLogged=FDC864*.

Conference Reports

54th Annual Meeting of the International Association of Forensic Toxicologists

(August 21–September 1, 2016; Brisbane, Australia)

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The 54th annual meeting of the International Association of Forensic Toxicologists (TIAFT) was held in Brisbane, Australia, from 28 August – 1 September. In addition to TIAFT, the meeting was jointly attended by delegates from the Forensic and Clinical Toxicology Association (FACTA) of Australia and the Society of Hair Testing (SoHT). The meeting was held at the Brisbane Convention and Exhibition Centre and was chaired by Prof. Olaf Drummer and his superb team of volunteers. Over 500 delegates from 47 countries attended the meeting, including 53 students and 36 members from developing countries that were sponsored, in part, by the organizing hosts and TIAFT. In addition, three individuals from Brazil and one from South Africa were able to attend the Congress through the TIAFT Developing Country Fund scholarship.

The meeting got off to a great start with a welcome reception on the terrace of the Convention Centre. Live music, cocktails, and passed hors d'oeuvres were enjoyed by the delegates as they caught up with old friends and made new ones.

The Opening Ceremony was held on Monday morning. The audience was welcomed by Olaf Drummer (President of FACTA and Organizing Committee Chair), Mark Stephenson (Secretary of FACTA and Local Organising Host), Hee Sun Chung (President of TIAFT), Markus Baumgartner (President of SoHT), and Ian Stewart APM (Commissioner, Queensland Police Service). After the introduction, a fascinating keynote lecture on the topic of Ambient Ionization Mass Spectrometry in Forensic Toxicology was given by Prof. Zoltan Takats from the Imperial College of London, UK. Over the course of the meeting, there were five additional keynote lectures. Presenters included Dr. Graham Jones (Canada), Dr. Gail Cooper (Scotland and USA), Prof. Volker Auwärter (Germany), Dr. Geoff Isbiter (Australia), and Prof. Christophe Stove (Belgium).

The scientific program got under way later Monday morning. Over the next four days, attendees had the opportunity to listen to 115 oral presentations and visit 209 poster presentations. Topics included Applications of Mass Spectrometry, Postmortem and General Forensic Toxicology, Hair Testing (with SoHT), Novel Psychoactive Substances, Drugs in Driving, Clinical and General Toxicology, Alternative Specimens, and Workplace Toxicology.

Tuesday afternoon featured a "scientific break" as attendees enjoyed a cruise up the Brisbane River on the Brisbane City Cat vessels. After a short bus transfer, delegates arrived at the Lone Pine Koala Sanctuary, which is recognized by the Guinness Book of World Records as the world's first and largest koala sanctuary with 130 koalas. Every attendee could have the picture taken with a cuddly koala in addition to enjoying other Australian wildlife in the Sanctuary including kangaroos, echidnas, platypus, emus, lorikeets, and more. Before boarding buses and returning to Brisbane City wine, cheese, and select microbrews were available for all to enjoy.

The TIAFT business meeting was held on Thursday afternoon; the membership selected the location of the 2020 TIAFT meeting to be Cape Town, South Africa – TIAFT's first visit to the African continent.

A gala dinner concluded the meeting at the Brisbane City Hall. The heritage-listed City Hall was built between 1920 and 1930 and includes a 4,600-pipe organ built in 1892 by Henry Willis and Sons (Liverpool, UK) that was moved to the City Hall in 1927 from the Brisbane Exhibition Building. The organ was completely restored for recent City Hall renovation and as attendees gathered for a wonderful three-course banquet, all were able to hear a wonderful organ concert complete with a fog machine and colored lights. The rest of the evening was full of food, socializing, and dancing. It was a wonderful time to celebrate international diversity, as there were representatives from close to 50 countries worldwide. The banquet included the roll call of nations — A time where attendees stand as their countries' names are called. One of the most enjoyable experiences of attending a TIAFT meeting is the opportunity to socialize with and learn about forensic toxicology from people from around the globe. Thanks to the organizing committee for a wonderful meeting! Next year TIAFT will meet in Boca Raton, FL (US) from September 9–14, 2017, jointly with the Society of Forensic Toxicologists (SOFT).

2016 International Conference on Criminal Investigation and Forensic Science

(September 1–2; Taipei, Taiwan)

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The 2016 International Conference on Criminal Investigation and Forensic Science was held at Central Police University (CPU) Taoyuan, Taiwan, September 1–2, 2016, as one of the activities in celebration of the CPU's 80th anniversary. Main conference organizers included the College of Police Science and Technology, the Department of Criminal Investigation, the Department of Forensic Science, the Department of Information Management, the Forensic Science Laboratory, the Center of Forensic Science and Criminal Investigation, the Center for Digital Forensics, and the Taiwan Academy of Forensic Science. Other sponsors include the Police Academic Research Foundation, the Henry C. Lee Forensic Science Foundation, Central Police University Alumni Association, The Military Police Command of the Ministry of National Defense, Research Center for Information Technology Innovation (Academia Sinica), Taiwan Victim Human Rights Service Association, and Rotary Club of Taipei Yanping. In addition, faculty and students from 17 universities and 7 invited forensic experts from the United States, Norway, Israel, and Japan were invited to present lectures.

The conference goals are to provide an environment to help forensic scientists keep pace with science and technology by highlighting advances in forensic science that have improved efficiency, quality, accuracy, reliability, and operational excellence. Sixty-five research papers

were presented in the conference including 40 oral and 25 poster presentations. The presenters are from the Bureau of Criminal Investigation, the Ministry of Justice Investigation Bureau, the Institute of Forensic Medicine Ministry of Justice, the Coast Guard Administration, and people from other law enforcement agencies and Justice System.

The Opening Address was delivered by President Diao. CPU alumnus Dr. Henry Lee delivered the plenary address on the topic of "New trends in criminal investigation and forensic science". During the conference sessions, participants had the opportunity to attend presentations on current trends in forensic science from a number of other countries:

- Mr. S. Chung Leung (Hong Kong): The forensics: Interface between science and law;
- Ms. Dana Sonenfeld (Israel): Explosives in Israel — Changes and development;
- Professor Ray H. Liu (US): Efforts and progresses in advancing the practice of forensic science in the United States of America;
- Dr. Barry K. Logan (US): Synthetic cannabinoids — prevalence, analysis, and effects on human;
- Dr. Hallvard Gjerde (Norway): Driving under the influence of non-alcohol drugs; and
- Professor Takeshi Honjo (Japan): Forensic science in Japan — Current status and on-going reforms

Looking Ahead: The National Sexual Assault Policy Symposium

(September 8–9; Washington, District of Columbia)

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RTI International
Research Triangle Park, North Carolina
United States of America

The National Institute of Justice, the research and development arm of the US Department of Justice, through its Forensic Technology Center of Excellence (FTCoE) hosted *Looking Ahead: The National Sexual Assault Policy Symposium* on September 8–9, 2016, in Washington, DC. The symposium addressed how the nation is moving forward and finding solutions to the complex issues that arise in sexual assault cases and in testing sexual assault evidence (*www.forensicCOE.org*).

This unprecedented event, which featured an array of stakeholders including governmental agencies, law enforcement, crime laboratories, victims' advocates, and medical and legal professionals, highlighted current accomplishments and shared valuable experiences from jurisdictions throughout the country. A number of policy makers also presented and took part in the panel discussions. The goal of the event was to support our nation's policymakers and practitioners as they drive future efforts to solve sexual assault cases, provide justice to victims, and ultimately improve public health and safety.

Key point topics during the two-day event included:

- Immediate aftermath of sexual assault — Understanding and responding to trauma;
- Victim-centered approaches to sexual assault first response;
- Progress on testing sexual assault kits — An update from the Nevada Sexual Assault Kit Backlog Working Group;
- Investigating sexual assault — Lessons learned and promised practices;
- Legislative reform — Addressing sexual assault across the nation;
- What is probative — The role of evidence in sexual assault cases;
- Behind the Pulitzer Prize-winning story *"An Unbelievable Story of Rape"* — How interagency cooperation led to the apprehension of a serial rapist;
- In the lab — Testing sexual assault evidence;
- Building an efficient laboratory using technology and innovative processes;
- Funding and resources to solve sexual assault cases; and
- Using multidisciplinary collaboration to improve Sexual assault response and create positive change.

Upon the conclusion of the Michigan National Sexual Assault Policy Symposium, Wayne County Prosecutor Kym Worthy and Assistant to the President and Chief of Staff to the First Lady Michelle Obama, Tina Tchen, provided closing remarks focusing on the importance of the national focus on sharing successful and timely solutions to the complex issues that are associated with first response and continued victim-centered care, and criminal investigation of sexual assault cases. The FTCoE posted online recordings of the event that are available resources to all. These archival sessions are located at *www.forensicCOE.org*.

21st International Council on Alcohol, Drugs and Traffic Safety Conference

(October 16–19; Gramado, Brazil)

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The 21st triennial conference of the International Council on Alcohol, Drugs and Traffic Safety (ICADTS) was held October 16–19 at Wish Serrano Resort & Conference in Gramado, Brazil. A total of 388 delegates from 30

countries attended the conference. This was the first time the ICADTS conference was held in a "non-high income country".

The organizing committee was led by Professor Dr. Flavio Pechansky from the Center for Drug and Alcohol Research of the Federal University of Rio Grande do Sul in Porto Alegre. Co-chairs were Dr. Renata P. Limberger and Dr. Tanara R. Sousa from the same university.

A preconference course entitled "Topics on impaired driving: research, prevention and policy" and a Global Road Safety Partnership seminar entitled "Impaired driving enforcement: priorities for managing drink and drug driving" were held on Sunday, October 16, 2016.

ICADTS President Kathryn Stewart (US) opened the conference by presenting a historical perspective of research on driving under the influence (DUI) of alcohol and drugs from the time of Professor Robert F. Borkenstein, who invented the Breathalyzer in 1954, until today. During this period, there has been an increased scientific understanding of the impact of alcohol and drug use on road traffic safety. This has affected public awareness and concern, and also changed the social norms and political will to reduce DUI, particularly in high-income countries. One major challenge is to adopt effective strategies to reduce alcohol and drug-related road traffic crashes in low- and middle-income countries (LMIC).

Each day of the conference started with a plenary session. The following "hot topics" were addressed: Assessing the impact of cannabis on driving; Effective measures to prevent DUI; and Nongovernmental approaches to drunk driving. Each plenary session was followed by breakout sessions and thereafter several concurrent sessions. In total, more than 100 oral presentations were given. The vast majority was in English and a few were in Portuguese, but simultaneous translation between English and Portuguese was provided for all sessions except one, which included presentations and discussions of local Brazilian matters. Twenty-one posters were also presented.

A special focus was put on the prevention of DUI in Brazil and other Latin American countries, as well as in LMIC in other parts of the world. Six presentations discussed DUI in LMIC in general, including which type of research data is missing. Challenges related to the implementation of measures to prevent DUI that have been proved to be effective in industrialized countries were also discussed. Data from Brazil were discussed in about 40 oral presentations and 14 posters, whereas data from other LMIC were discussed in about 10 oral presentations and one poster.

The legalization of cannabis in some countries and states may affect road traffic safety. Dr. Marilyn Huestis (US), Dr. Renata Limberger (Brazil), and Dr. Jan Ramaekers (The Netherlands) presented three excellent plenum lectures on the topic. This was followed by two sessions on cannabis and cannabinoids with a total of eight presentations. Experimental studies have shown that acute cannabis intoxication affects psychomotor and cognitive functions that are required to drive safely. Some data also suggest that heavy cannabis users may have reduced psychomotor and cognitive functions also after the acute intoxication phase. Epidemiological studies are often poorly designed, giving a bias toward incorrectly low risk estimates. However, acute cannabis intoxication has been found to increase the crash risk significantly.

Other sessions focused on topics such as the epidemiology, detection, and prevention of DUI of alcohol, medicinal drugs, illicit drugs, and new psychoactive substances; legal issues and enforcement; young DUI offenders; DUI among professional drivers; NGOs work against DUI; and cutting-edge technologies. Analytical methods for drugs were also presented and discussed, but to a much less extent than at forensic toxicology conferences.

During the conference dinner Tuesday night, a number of awards were presented. The Borkenstein Award, which recognizes individuals who have made outstanding contributions to international cooperation in alcohol- and drug-related traffic safety programs, was given to Dr. Ralph W. Hingson (US) for his contributions for the World Health Organization's Global Strategy to Reduce the Harmful Use of Alcohol, The Pan American Health Organization Networks on Alcohol and Public Health and Alcohol and Global Health, and for his contributions within ICADTS, including that of past president. The Haddon Award, which recognizes meritorious service by nongovernmental organizations was given to the Thiago de Moraes Gonzaga Foundation "Vida Urgente"; *http://www.vidaurgente.org.br/* (Brazil) for its work to raise awareness of and lobby for tougher sanctions and penalties for drunk and reckless driving. The Widmark Award honors organizations and individuals who have made an outstanding, sustained, and meritorious contribution to the field that has led to international standing and respect. The Widmark Institutional Award was presented to the European DRUID Project (Driving under the Influence of Drugs, Alcohol and Medicines; *http://www.druid-project.eu*), and accepted by DRUID Coordinator, Dr. Horst Schulze. The DRUID Project is the largest research project on alcohol, drugs, and traffic safety performed until now. The Widmark Personal Awards were presented to Dr. Asbjørg S. Christophersen (Norway) for her contributions regarding the analysis of illicit drugs, medicine, and metabolites in DUI cases and in epidemiological studies; and to Mr. René Mathijssen (The Netherlands) for his contributions in alcohol and drug prevalence and risk studies, the effects of police enforce-

ment, publicity and education, and alcolock programs in the EU and the Netherlands. The official conference tour took place after the closing ceremony October 19. The next ICADTS conference will be held in 2019 in Edmonton, Canada. For more information, *see http://icadtsinternational.com* or *http://t2019.org*.

Forensics@NIST 2016: Practitioners and Researchers Meet at a Critical Time for Forensic Science

(November 8–9, 2016; Gaithersburg, Maryland)

R. Press

National Institute of Standards and Technology
Gaithersburg, Maryland
United States of America

On November 8–9, 2016, experts gathered for the fourth biennial Forensics@NIST conference, where scientists from the National Institute of Standards and Technology (NIST) presented their latest research on ballistic toolmarks, fingerprints, digital forensics, trace evidence, DNA profiling, and more. In addition, experts from the NIST-funded Center for Statistics and Applications in Forensic Evidence discussed their efforts to bring new probabilistic methods to bear on forensic evidence.

More than 250 forensic experts attended, including many from the nation's largest crime labs, and several hundred more participated via webcast. None of the NIST researchers who presented their work are practicing forensic scientists. They are chemists, physicists, biologists, and engineers. But they are experts in metrology — the science of measurement — and they are developing new and better ways to measure things objectively, accurately, and with known uncertainties, and to express those measurements in statistically meaningful ways.

The two-day technical program included presentations on:

- Statistics;
- Digital and identification forensics;
- Illicit drugs and toxins;
- Ballistics and associated tool marks;
- Trace evidence;
- Forensic genetics; and
- Human factors.

As NIST research manager Robert Thompson noted in his closing remarks, forensic labs have limited budgets, yet demand for their services is increasing. NIST scientists are working to build tools that will help forensic practitioners work more efficiently, and more accurately and reliably, in support of a safer, more just society.

A video archive of the entire Forensics@NIST 2016 conference, and downloadable PDFs of the presentations, are available on line.

Symposium on Forensic Mass Spectrometry

(November 11, 2016; Verona, Italy)

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Verona, Italy

In the frame of the theoretical formation offered by the PhD Program in Nanoscience and Advanced Technologies at the University of Verona and in collaboration with the Italian Mass Spectrometry Society, a Symposium on Forensic Mass Spectrometry (FMS Verona 2016) was held November 11, 2016, in Verona, Italy. The purpose of the symposium was to gather eminent experts in the discipline in order to give to the PhD students the most qualified updates in this rapidly emerging subject and at the same time to offer an opportunity for interdisciplinary discussion among the participants. The meeting was hosted by the Department of Diagnostics and Public Health of the University of Verona, and was chaired by Prof. Franco Tagliaro (Director of the PhD Program), and co-chaired by Dr. Giacomo Musile.

The opening address was given by Prof. Tagliaro and by Dr. Enrico Davoli (head of the Mass Spectrometry Laboratory at the Mario Negri Institute for Pharmacological Research and president of the Italian Mass Spectrometry Society).

The scientific program started with a plenary lecture by Dr. Simona Francese (Sheffield Hallam University, UK) on the development of MALDI profiling and imaging methodologies to recover additional intelligence from fingermarks.

During the day, participants had the opportunity to attend other presentations and to visit nine posters on different subjects of forensic science, and particularly on:

- Analysis of explosives (Prof. Francesco Romolo, Sapienza University);
- Entomotoxicology (Dr. Stefano Vanin, University of Huddersfield);
- Protein signature of aging blood spots (Dr. Thalassa Valkenburg, University of Leicester);
- Characterization of polymer trace evidences (Dr. Valerio Causin, University of Padova);
- Electron ionization-mass spectrometry (Prof. Pierangela Palma, University of Urbino);

- Capillary electrophoresis-mass spectrometry (Dr. Rossella Gottardo, University of Verona);
- Identification of peptide and protein doping agents (Dr. Marco Roverso, CNR-ICMATE of Padova); and
- Forensic toxicology (Prof. Herbert Oberacher, Medical University of Innsbruck; Dr. Manuela Fontana, University of Palermo; Dr. Fabio Vaiano, University of Florence; Dr. Giampietro Frison, Azienda ULSS 12 Veneziana)

During the symposium, the award for best poster presentation was presented to Cristina Bozzolino from University of Torino, for her work "Incidence of new psychoactive substances in drug abuse within various populations and countries: evidences from hair analysis". In addition to the PhD students at the University of Verona, about 90 people attended from all over Italy, Austria, Great Britain, The Netherlands, and Switzerland.

Upcoming Events

American Academy of Forensic Sciences (AAFS) — 69th Annual Meeting
February 13–18, 2017; Hyatt Regency New Orleans
New Orleans, LA, US

PITTCON Conference and Expo
March 5–9, 2017; McCormick Place
Chicago, IL, US

International Association for Chemical Testing 2017 Conference
April 23–28, 2017; Cheyenne Mountain Resort
Colorado Springs, CO, US

American Society of Crime Laboratory Directors — Annual Symposium
April 30 – May 4, 2017; Sheraton Dallas Hotel
Dallas, TX, US

Annual Meeting on Forensic Chemistry
May 1–3, 2017; venue to be announced
Barcelona, Spain

California Association of Toxicologists (CAT) 50th Anniversary Meeting
May 5–6, 2017; Paradise Point Resort
San Diego, CA, US

California Association of Criminalists (CAC) Spring Conference 2017
(Hosted by San Francisco Police Department Laboratory)
May 9–12 2017; Hotel Kabuki
San Francisco, CA, US

The Association of Firearm and Tool Mark Examiners (AFTME) Meeting
May 14–19, 2017; Grand Hyatt Denver
Denver, CO, US

Mid-Atlantic Association of Forensic Scientists (MAAFS) Annual Meeting
May 22–25, 2017; Sheraton Station Square
Pittsburgh, PA, US

10th International Society for Applied Biology and Science (ISABS) Conference on Forensic and Anthropologic Genetics and Mayo Clinic Lectures in Individualized Medicine
June 19–24, 2017; Hotel Dubrovnik Palace
Dubrovnik, Croatia

International Association for Identification (IAI) — International Educational Conference
August 6–12, 2017; Georgia World Congress Center;
Official meeting hotel: Omni Atlanta Hotel at CNN Center
Atlanta, GA, US

International Association of Forensic Sciences (IAFS) — Annual Meeting
August 21–25, 2017; Sheraton Centre Toronto,
Toronto, ON, Canada

Society of Forensic Toxicologists (SOFT) and the International Association of Forensic Toxicologists (TIAFT) Joint Annual Meeting
September 10–15, 2017; Boca Raton Resort & Club
Boca Raton, FL, US

Midwestern Association of Forensic Scientists (MAFS) and the Southern Association of Forensic Scientists (SAFS) Joint Annual Meeting
September 16–22, 2017; The Westin Cincinnati
Cincinnati, OH, US

6th International Conference on Forensic Research & Technology
Sep 18–20, 2017; venue to be announced
Houston, TX, US

Northwest Association of Forensic Scientists (NWAFS) Annual Meeting
September 17–22, 2017; Embassy Suites by Hilton (Portland-Airport)
Portland, OR, US

California Association of Criminalists (CAC) Fall Conference 2017
(Hosted by Orange County Crime Laboratory)
Sept 25–30, 2017; Fairmont Hotel
Newport Beach, CA, US

Southwestern Association of Forensic Scientists (SWAFS) Annual Meeting
October 22–26, 2017; Stockyards Hyatt Place and the Stockyards Station
Fort Worth, TX, US

Northeastern Association of Forensic Scientists (NEAFS) Annual Meeting
November 7–10, 2017; Kalahari Resort & Conference Center
Pocono Manor, PA, US

Forensic Science Educational Programs (IV) — Europe (Excluding UK & Ireland)

Pierre Margot*

School of Criminal Science
Faculty of Law, Criminal Science, and Public Administration
University of Lausanne
Lausanne, Switzerland

Jose Gonzalez-Rodriguez

School of Chemistry
University of Lincoln
Lincoln, Lincolnshire
United Kingdom

The situation of forensic science education in Europe is a patchwork that is difficult to sort out. In many countries there are no specific studies dedicated to forensic science, leading to a degree open to nongovernment employees. In these countries there are connections between official, state, or police laboratories with academic institutions and possibilities of internal education leading to an academic status. In many European countries, forensic science activities and research may be conducted in forensic medicine departments, but without degree courses except for the medical specialization. Many countries also offer some courses in forensic science to law students or as part of a criminology program. There is sometimes no indication in English about the content of programs, or you need to register to some university application form to get access to programs. Finally, there is a network of universities claiming to offer forensic science degrees, but that are mostly not offered on-site. None of these programs is included in the list shown below. Programs in the United Kingdom and Ireland are not included either; they are the object of a separate document (*Forensic Sci Rev* 27:7–9 ; 2015).

Included in this list are academic departments leading to degrees in forensic science in higher education institutions. Some advanced projects known to the authors are cited, but without guarantees that they will provide degrees within a short time.

Table 1. Forensic science university courses in Europe (excluding UK & Ireland)

Institute/program's housing unit/ location/website	Degree & course title	Course language
Austria		
Medical University of Vienna Department of Forensic Medicine Forensic Molecular Biology Vienna *https://www.meduniwien.ac.at/hp/fileadmin/gerichtsmedizin/DGM_Org_neu_2016/2016_05_17_Org_eng.pdf*	(In development)	German
Bulgaria		
Varna Free University Department of Security and Safety Law Faculty Varna *http://vfu.bg/en/ects_guide/files/uf/mag/se/ske.html*	Master: Forensic Science Expertise	Bulgarian
Germany		
Steinbeis College Berlin *http://www.fachhochschule.de/FH/Studium/Master_of_Arts_Criminal_Investigation_17738.htm*	MA: Criminology	German
University Humbolt Berlin *http://www.kcl.ac.uk/study/postgraduate/taught-courses/forensic-science-msc-mres-pg-dip-pg-cert.aspx*	(A historical well known program was closed in 1994, following the fall of the Berlin Wall. Currently, programs are offered in partnership with King's College London)	
Bonn-Rhein-Sieg University of Applied Sciences Department of Natural Sciences Sankt Augustin *https://www.h-brs.de/en/anna/forensic-sciences-bsc*	BSc: Forensic Sciences	German (50%) English (50%)
Brandenburg University of Technology Cottbus-Senftenburg Faculty of Environment and Natural Sciences Cottbus *https://www.b-tu.de/en/study/study-programmes/detail/123-forensic-sciences-and-engineering*	MSc: Forensic Sciences & Engineering	German

Table 1. (Continued)

Institute/program's housing unit/ mailing address//website	Degree & course title	Course language
Italy		
Sapienza University of Roma Faculty of Physical and Natural Sciences Rome *http://www.uniroma1.it/didattica/master/2015/metodologie-analitiche-forensi-0*	MSc: Forensic Analytical Method	Italian
University of Bologna Professional Master's Programmes Bologna *http://www.unibo.it/en/teaching/professional-master/2015-2016/forensic-chemical-and-chemical-toxicological-analyses-8638*	MSc: Forensic Chemical & Chemical-Toxicological Analyses	Italian
The Netherlands		
The University of Amsterdam Institute for Interdisciplinary Studies Graduate Schools of Sciences Amsterdam *http://gss.uva.nl/future-msc-students/content/forensic-science.html*	MSc: Forensic Science	English
Avans University of Applied Sciences Breda *http://www.avans.nl/international/programs/programfinder/international-forensic-science-short-programme-breda-voltijd-short-course/introduction*	Bachelor of Chemistry Bachelor of Biology	English & Dutch
Portugal		
The University of Coimbra Faculty of Medicine Rua Larga, Coimbra *https://apps.uc.pt/courses/en/course/1392*	Master: Legal Medicine & Forensic Science	Portuguese
Instituto Superior de Ciências da Saúde Egas Moniz Higher Health Sciences Egas Moniz Institute Lisbon *http://www.egasmoniz.com.pt/pt-pt/ensino/iscsem/cursos/licenciaturas/licenciatura-em-ciências-forenses-e-criminais.aspx*	BA: Forensic & Criminal Sciences	Portuguese
Spain		
The Autonomous University of Barcelona Graduate School Cerdanyola del Vallès, Barcelona [a] *http://www.uab.cat/web/postgraduate/master-in-criminology/general-information-1217916968009.html/param1-1487_en/param2-2014/* [b] *http://www.uab.cat/web/postgraduate/graduate-diploma-in-criminalistics-analysis-of-information-and-advanced-techniques-in-forensic-sciences/general-information-1217916968009.html/param1-1471_en/param2-2014/* [c] *http://www.uab.cat/web/postgraduate/graduate-diploma-in-forensic-science-and-criminal-intelligence/general-information-1217916968009.html/param1-3002_en/param2-2014/* [d] *http://www.uab.cat/web/postgraduate/graduate-diploma-in-forensic-handwriting-analysis/general-information-1217916968009.html/param1-3058_en/param2-2013/*	Master: Criminology — Forensic Science[a] Graduate Diploma: Criminalistcs[b] Forensic Science & Criminal Intelligence[c] Forensic Handwritting Analysis[d]	Spanish
The University of Alcalá University Research Institute of Police Sciences Faculty of Law Alcalá de Henares, Madrid [a] *https://www.uah.es/es/estudios/estudios-oficiales/masteres-universitarios/Ciencias-Policiales/* [b] *https://www.uah.es/es/estudios/estudios-oficiales/doctorados/Ciencias-Forenses-D412/*	Master: Police Science[a] PhD: Forensic Science[b]	Spanish Spanish
University of Murcia Faculty of Biology Espinardo Campus Murcia *http://www.um.es/web/biologia/contenido/estudios/masteres/ciencias-forenses*	Master: Forensic Sciences	Spanish
University of the Basque Country Master and Doctoral School Basque *http://www.ehu.eus/en/web/masteranalisisforense/aurkezpena*	Master: Forensic Analysis	Spanish/ Basque

Table 1. (Continued)

Institute/program's housing unit/ mailing address//website	Degree & course title	Course language
University of Valencia Department of Preventive Medicine Valencia *http://formacion.adeituv.es/ciencias-forenses/#*	Master: Forensic Science	Spanish
Pablo de Olavide University Social and Legal Sciences Seville *https://www.upo.es/postgrado/Master-Oficial-Criminologia-y-Ciencias-Forenses*	Master: Criminology & Forensic Science	Spanish
Sweden		
The University of Uppsala Faculty of Medicine Uppsala http://www.uu.se/en/admissions/master/selma/program/?pKod=MFV2M&lasar=16/17 http://www.uu.se/en/admissions/master/selma/utbplan/?pKod=MFV2M&lasar=16%2F17	MSc: Forensic Science	
Switzerland		
The University of Lausanne Batiment BCH Lausanne *www.unil.ch/esc* [a] *http://www.unil.ch/esc/bachelor* [b] *http://www.unil.ch/esc/master-id* [c] *http://www.unil.ch/esc/master-cc* [d] *http://www.unil.ch/esc/master-tracologie* [e] *http://www.unil.ch/esc/msc-investigation-numerique*	BSc: Forensic Science[a] MSc: Physical Identification[b] Chemical Criminalistics[c] Traceology & Crime Analysis[d*] Digital Investigation & Identification[e] PhD: Forensic Science[f] Certificate: Essentials of Forensic Interpretation[g] Essentials of DNA Interpretation[i] Certificate of Advanced Studies: Statistics in the Interpretation of Evidence[h]	French French French French French French & others English English English
[f] *http://www.unil.ch/esc/home/menuinst/doctorats-et-recherches/doctorat-en-science-forensiq.html* [g] *http://www.formation-continue-unil-epfl.ch/essentials-forensic-interpretation* [h] *http://www.formation-continue-unil-epfl.ch/statistics-evaluation-forensic-evidence-cas* [i] *http://www.formation-continue-unil-epfl.ch/essentials-dna-interpretation* [*] With the University of Montréal, Department of Criminology)		
Turkey		
Istanbul University Institute of Forensic Sciences Cerrahpasa Kampusu Istanbul [a] *http://adlitip.istanbul.edu.tr/en/ms-in-forensic-sciences/* [b] *http://adlitip.istanbul.edu.tr/en/phd-in-forensic-sciences/*	MS: Forensic Science[a] PhD: Forensic Science[b]	Turkish Turkish

ADVANCING THE PRACTICE OF FORENSIC SCIENCE IN THE US — UPDATES

In 2013 the US National Institute of Standards and Technology (NIST) and the US Department of Justice (DOJ) signed a memorandum of understanding for a new initiative to strengthen the practice of forensic science. The Organization of Scientific Area Committees (OSAC), which is administered by NIST, fosters the development and promotion of technically sound, consensus-based documentary standards and guidelines that can be used to strengthen the practice of forensic science. The OSAC consists of a Forensic Science Standards Board (FSSB), three resource committees, five scientific area committees, and 25 subcommittees with members from various disciplines and organizations including federal, state, and local government, private sector, and academia.

The DOJ's National Institute of Justice (NIJ) created the Forensic Technology Center of Excellence (FTCoE) in 2007 to support its research, development, testing, and evaluation. Since 2011, the FTCoE has comprised RTI International and its academic partners. The goals of the FTCoE are to determine technology needs; develop technology program plans to address those needs; provide solutions; demonstrate, test, evaluate, and transition potential solutions into practice; develop and update technology guidelines; and build capacity and conduct

outreach. Services are customized to support forensic service providers such as crime laboratories, corrections and court agencies, and other criminal justice practitioners to combat crime. Through these efforts, the FTCoE increases the capacity of state and local law enforcement to effectively and professionally serve society in matters involving forensic science, crime, and public safety.

National Institute of Standards and Technology Forensic Science Updates

Rich Press

National Institute of Standards and Technology
Gaithersburg, Maryland
United States of America

Organization of Scientific Area Committees Registry

The Organization of Scientific Area Committees is working to strengthen forensic science by facilitating the development of discipline-specific, science-based standards and guidelines for a broad array of forensic disciplines. To be posted to the OSAC Registry, standards and guidelines must have been developed using a consensus-based process that includes public comment and must pass a review of technical merit by forensic practitioners, academic researchers, statisticians, and measurement scientists.

Laboratory Standard ISO/IEC. In late September 2016, the OSAC for Forensic Science announced the addition of the International Organization for Standardization (ISO) and International Electrotechnical Commission's (IEC) *17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories* to the OSAC Registry.

ISO/IEC 17025:2005 specifies the general competency requirements for conducting laboratory tests and calibrations, including sampling, using standard methods, nonstandard methods, and laboratory-developed methods. This document applies to all organizations performing tests or calibrations, including first-, second-, and third-party laboratories, and laboratories that conduct tests or calibrations related to product inspection and certification.

Scott Oulton, chair of the OSAC Chemistry/Instrumental Analysis Scientific Area Committee, led the formation of an interdisciplinary subcommittee including members from throughout OSAC that reviewed and approved ISO/IEC 17025 to the OSAC Registry. In September, the OSAC's Forensic Science Standards Board provided the final approval to list ISO/IEC 17025 on the OSAC Registry.

"While this standard is already widely implemented in the domestic and international forensic science community, the interdisciplinary subcommittee believed this standard should be added to the OSAC Registry to broaden its impact," Oulton said. Oulton said that including ISO/IEC 17025 on the OSAC Registry will broaden its impact by:

- Promoting and facilitating technical competence and valid test and inspection results
- Encouraging all laboratory-based forensic science service providers, regardless of size, to implement the standard
- Motivating smaller laboratories to seek the funding and personnel they need to implement the standards.

ISO/IEC 17025 is very broad in that it applies not just to forensic laboratories, but to all testing and calibration laboratories. Accrediting bodies customize the application of ISO/IEC 17025 to forensic laboratories by applying forensic-specific supplemental standards and documents. "17025 really serves as an umbrella standard that many of OSAC's other approved standards and guidelines can fall under when laboratories engaged in the practice of forensic science approach the accreditation process," said Mark Stolorow, director of OSAC affairs. "The OSAC Registry is positioned to serve as the one-stop shop for approved standards and guidelines in the forensic science industry."

National Fire Protection Association Guide for Fire and Explosion Investigations. The OSAC for Forensic Science has approved the *National Fire Protection Association Guide for Fire and Explosion Investigations* for inclusion on the OSAC Registry, which serves as a trusted repository of high-quality, science-based standards and guidelines for forensic practice. This is the first guideline to be included on the OSAC Registry, where it joins the first standard, which was listed earlier this year.

NFPA 921: Guide for Fire and Explosion Investigations, 2014 Edition applies to the investigation of all types of fire and explosion incidents, both accidental and intentional, from residential and motor vehicle fires to multistory high-rise fires and industrial plant explosions. Craig Beyler, the chair of OSAC's Fire & Explosion Investigation Subcommittee, shepherded the guide through the OSAC approval process. "NFPA 921 is regarded as the standard of care in the fire and explosion investigation community and in the courts," Beyler said. "It sets a high bar for science-based investigation and analysis of fire and explosion incidents."

NFPA 921 addresses all aspects of fire and explosion investigation, including methodology, evidence collection, and failure analysis. The document is used in the field, in training, and in court, and it serves as a guide for ren-

dering accurate opinions on origin, cause, responsibility, and prevention. Fire investigators who work for public agencies, insurance companies, and litigation firms all rely on this document in their daily work.

Mark Stolorow, director of OSAC affairs at NIST, explained that OSAC scrutinizes existing standards and guidelines from a range of standards developing organizations for their technical merit and due process. "Elevating NFPA 921 to the official OSAC Registry is an endorsement of the high quality of this document and encourages its adoption by all agencies and practitioners who investigate scenes of fires and explosions," Stolorow said.

OSAC does not have authority to enforce standards. However, by endorsing standards, OSAC promotes their adoption by forensic science service providers and by accrediting bodies that audit participating agencies for compliance.

While accredited forensic service providers are currently audited to general laboratory standards, there are very few discipline-specific standards that the laboratories can be audited against. The goal of OSAC and its 550-plus members is to facilitate the development of science-based standards for each of 25 distinct forensic science disciplines and to promote their widespread adoption.

Project Updates

Trace Evidence Databases: A Force Multiplier for Forensic Investigators. A window is broken. A home is burglarized. Investigators identify a suspect and find a sliver of what appears to be glass embedded in his shoe. In the forensics lab, examiners determine, using advanced microscopy and chemical analysis, that the characteristics of that sliver match those of the broken glass in the burgled home. Pretty strong evidence, right?

Not so fast, says Shannan Williams, who manages the trace evidence research program at NIST. "If those characteristics are common, that sliver of glass might match half the windows in town. But if they're rare, the evidence can be extremely powerful." That's why one of the most important tools available to trace evidence examiners is not a microscope or a chemical reagent, but a database. Besides glass, trace evidence includes hair and fibers, fire debris, metal, paint, adhesives, and explosives, to name just a few. Large databases that describe these materials — and the variability among them — make individual pieces of trace evidence far more powerful than they would be alone.

Unfortunately, much data on trace evidence is scattered in databases at forensic labs and research departments where they are unavailable to the wider forensic community. But Williams and many others are working to change that. Many of those individuals attended a workshop at NIST on July 19–20, 2016, where experts discussed trace evidence databases and the steps needed to make them more useful and widely available.

During his presentation, Claude Roux of the Centre for Forensic Science at the University of Technology in Sydney, Australia, said that trace evidence faces an uncertain future as an investigative tool, in part because, unlike DNA evidence, it does not have the power to directly identify suspects. Roux argued that this emphasis on identification can lead people to undervalue trace evidence, which can be used to generate leads, eliminate suspects, reconstruct sequences of events, and identify links in serial crimes.

Sandra Koch, who sits on the Materials Subcommittee of the OSAC for Forensic Science, presented findings that also pointed to an uncertain future for trace evidence. Koch surveyed trace evidence lab managers, with many reporting that trace evidence is often perceived as a "junk science" with little or no value. An increasing number also face shrinking budgets.

In the face of these uncertainties, workshop participants discussed ways to increase the power of trace evidence through expanded access to trace evidence databases. In addition, experts from NIST, the Federal Bureau of Investigation, and the National Institute of Justice gave presentations on databases that their agencies make available to the forensic science community Workshop participants also discussed ways to make other trace evidence databases and collections — many compiled by individual forensic laboratories during years of casework, others created by manufacturing companies — more widely accessible to the forensic community.

Williams hopes that these efforts will help ensure that trace evidence remains a vital tool for crime fighters. "Trace evidence databases are force multipliers," Williams said. "They make every lab that uses them more effective." Information about the Trace Evidence Workshop, including video and downloadable presentations, can be found at *https://www.nist.gov/news-events/events/2016/07/trace-evidence-data-workshop-improving-technology-and-measurement*.

NIST 3D Ballistics Research Database Goes Live. It's a staple of the TV-crime drama: a ballistics expert tries to match two bullets using a microscope with a split-screen display. One bullet was recovered from the victim's body and the other was test-fired from a suspect's gun. If the striations on the bullets line up — cue the sound of a cell door slamming shut — the bad guy is headed to jail.

In the real world, identifying the firearm used in a crime is more complicated. However, the basic setup is the same. Ballistics examiners match bullets visually, and they've been doing it this way for almost 100 years. But testimony based on visual examination leaves out something important.

"When an expert testifies that two bullets are a match, the jury wants to know, 'How good a match is it?'" said Xiaoyu Alan Zheng, a mechanical engineer who conducts forensic science research at NIST. "No forensic results have zero uncertainty."

Researchers are developing statistical methods for quantifying that uncertainty, and the main obstacle they face is a lack of sufficient data. This month NIST released the largest open-access database of its kind —the NIST Ballistics Toolmark Research Database — to help remove that obstacle.

Zheng explains that when a ballistics examiner testifies in court that a bullet was or was not fired by a particular gun, they currently lack the ability to attach a statistical measure of confidence to their testimony. NIST's new 3D Ballistics Research Database will help solve that problem.

Led by Zheng, this database effort is partly in response to a 2009 report from the National Academy of Sciences, which highlighted the need for statistical methods to estimate uncertainty when matching ballistic and other types of forensic pattern evidence. The development of the database was largely funded with a grant from the National Institute of Justice.

When matching a bullet to a gun, examiners look at striations that are carved into the bullet by rifling in the gun›s barrel. If the cartridge case is left behind, they can also look at impressions left on it by the weapon›s breech face and firing pin.

But these clues can sometimes be misleading. For instance, two gun barrels that are manufactured consecutively may produce bullets with very similar markings. That can lead to false matches. On the other hand, a gun might change over a short time due to wear on the parts or accumulation of debris in the barrel. If that happens, a single firearm might produce bullets that look like they were fired from different guns.

These confounding factors introduce uncertainty into examination results. Researchers would like to quantify this uncertainty using statistical methods, and to do that they need large databases of test-fired bullets and cartridge cases. The databases already in use for solving crimes, such as the National Integrated Ballistics Information Network (NIBIN), are proprietary and contain sensitive information. Researchers cannot download bulk data from them for use in statistical studies. The NIST database, on the other hand, is open-access and the data is freely available.

To seed the database with data, Zheng went to forensics and law enforcement conferences asking agencies to test-fire every 9-mm firearm in their reference collection — 9 mm being the caliber most commonly used in the commission of crimes. After completing the test fires, labs sent the bullets and cartridge cases to Zheng at NIST, along with data on the gun that fired it. At the lab, technicians scanned these samples using a microscope that produces a high-resolution, 3-D topographic surface map — a virtual model of the physical object itself.

The database currently has about 1,600 test fires, a relatively small number. "But, it's like the first forensic DNA databases," Zheng said. "They started off small but filled up quickly."

In the meantime, the data that are available are already proving useful. Eric Hare is a PhD student in statistics at Iowa State University whose work is supported by the Center for Statistics and Applications in Forensic Evidence (CSAFE), which is funded by NIST. Hare is using the NIST research database to develop machine learning-based bullet-matching algorithms.

As the database grows in size, the algorithms will become increasingly accurate. And as the database grows in variety to include different types of ammunition and weapons, the algorithms will become more broadly useful. The database already contains test fires from consecutively manufactured firearms, and Hare is testing whether the algorithms can reliably distinguish between them. Perhaps most importantly, Hare's code is open source. That means other researchers can check for bias or error in the algorithms, and correct any that are found. "In high-profile situations where there's a lot at stake, it would be good if everyone knew exactly what the algorithms were doing," Hare said.

The FBI recently agreed to contribute a large dataset of test fires from its reference collection of several thousand firearms, which will greatly increase both the size of the database and the diversity of firearms it covers. Zheng hopes that other forensic labs with 3-D microscopes will start uploading their data to the database as well. With the database now available, the real work has just begun.

Forensic Technology Center of Excellence Updates

Forensic Technology Center of Excellence: Informing the Advancement of Emerging Technologies — A 2016 Update —

J. D. Ropero-Miller

Center for Forensic Sciences
RTI International
Research Triangle Park, North Carolina
United States of America

An RTI International-led consortium was recently selected by the National Institute of Justice (NIJ) to further improve the safety and effectiveness of criminal justice technologies for forensic science cases as its Forensic

Technology Center of Excellence (FTCoE). The competitive five-year Cooperative Agreement grant was issued to RTI's Center for Forensic Sciences furthered strengthened with a multidisciplinary team composed of RTI's Centers for Justice, Safety and Resilience, and Innovation Advisors.

Simply developing or identifying new forensic technologies does not guarantee that the criminal justice community will successfully adopt and integrate it. Thus, the FTCoE bridges the gap between science and justice by delivering practical technology transition and knowledge transfer to the criminal justice community for the improvement of forensic science. With this award, RTI and its consortium partners will continue to improve, build, and develop capacities to support technology adoption and social science programs nationally.

The FTCoE supports the NIJ's research, development, testing, and evaluation process in all areas of forensic science. To help improve public safety, the center also disseminates best practices and guidelines to crime laboratories, forensic service providers, and law enforcement. Per NIJ's directive, the FTCoE focuses on the following:

- Providing scientific and technical support to NIJ's research and development effort;
- Facilitating demonstration, transfer, and adoption of appropriate technology into practice by crime laboratories, forensic science service providers, law enforcement, and other criminal justice agencies;
- Providing technology assistance, information, and support to law enforcement and other appropriate criminal justice agencies;
- Developing and providing access to resources for research, education, and best practices in the forensic science and criminal justice community; and
- Working closely with NIJ's social science staff to assess and communicate the impact of forensic science on the criminal justice system.

RTI has led the FTCoE since 2011. The consortium includes RTI, 2N's Forensic, Inc., the American Academy of Forensic Sciences, Battelle Memorial Institute, the Center for Forensic Nursing International, Duquesne University, Florida International University, George Washington University, Michigan State University, the North Carolina State University, Seattle University — Department of Criminal Justice, University of Central Florida, the University of New Haven, the University of North Texas — Department of Forensic and Investigative Genetics and the Center for Human Identification, and West Virginia University.

Project Updates

Landscape Study of Mobile Evidential Breath. The NIJ's FTCoE at RTI International (RTI), in collaboration with key stakeholders and manufacturers, developed a landscape study of mobile breath alcohol instruments, including both transportable and handheld instruments. This study compiles performance statistics about the available transportable and handheld instruments approved for evidential data collection. It summarizes these devices' variables including price, features, and accessories, and also identifies any procedures and best practices from agencies currently using portable instruments. Feedback regarding the ease of use in the field and overall satisfaction for the most widely used instruments is also detailed. The report includes devices manufactured by CMI, Dräger, Intoximeters, and Lifeloc. In an initial survey of breath alcohol program personnel, concerns regarding the reliability or defensibility of data acquired using mobile breath alcohol instruments were cited as the primary barrier to implementation. To the extent possible, the report includes case studies of the defensibility of evidential data from agencies currently using mobile instruments. This report was made available in December 2016 at *www.forensicCOE.org*.

Massively Parallel Sequencing in the World of DNA — Report on the Application to Forensics and a Virtual Laboratory Simulation Tool. Massively parallel sequencing (MPS), also called next-generation sequencing, is an exciting technology that holds promise for enhancing the capabilities of forensic DNA laboratories. However, several challenges confront the implementation of an MPS system in a crime laboratory. These challenges include laboratory methodology and validation, training and education on the fundamentals of the technologies and chemistries, functionality, genetic marker systems, interpretation guidelines, policy and data procedure developments related to Combined DNA Index System (CODIS) operations, and perceived admissibility and privacy issues. In 2016, the FTCoE released two resources to assist practitioners more readily understand and utilize MPS. First, as part of a workshop at the International Symposium on Human Identification (ISHI) in Minneapolis, MN, on September 26, 2016, the FTCoE, in collaboration with the University of North Texas Health Science Center, and North Carolina State University, presented on the topic of best practices to implement MPS into a typical forensic laboratory workflow. This effort led to the development and online release of an immersive and interactive virtual simulation tool that guides DNA practitioners through three commercially available forensic laboratory processes amenable to two MPS instruments. Second, the FTCoE released a final report detailing the outcome of its webinar series that covered the fundamentals of the current platforms

and chemistries, the capacity and throughput of genetic marker analysis, bioinformatics and validation requirements, potential applications, and potential admissibility issues related to implementing an MPS system in a crime laboratory. The simulation tool and the final report was made available in October and December 2016, respectively, at 2016 at *www.forensicCOE.org*.

Evaluation of AquilaScan Oral Fluid Device and Comparison of Blood and Oral Fluid Concentrations. The objective of this project is to evaluate the performance of the AquilaScan drug analyzer (PAS Systems International, Inc., Fredericksburg, VA, US) via laboratory-based and field testing. The AquilaScan's performance in the laboratory is being tested using negative and drug-spiked human oral fluid samples at ± 25% and ± 50% of the manufacturer's claimed cutoff concentrations. Interferences, crossreactivity, and environmental factors are also being evaluated. The reliability and ease of use of the device is being evaluated under varied environmental conditions including extreme temperatures and low light. In addition to laboratory-based testing, the instrument will undergo field testing that will include the collection of paired oral fluid and blood samples from donors. One oral fluid sample will be analyzed immediately after collection using the AquilaScan. The results will then be compared to those obtained from an additional oral fluid sample collected in a Quantisal device and a blood sample, both of which will be analyzed by a reference laboratory for confirmation testing. This report was made available in January 2017 at 2016 at *www.forensicCOE.org*.

The Multidisciplinary Sexual Assault Glossary. The FTCoE in collaboration with the Center for Nursing Excellence International (CFNEI) has developed a Sexual Assault online glossary for medical, law enforcement, and legal professionals. Effective communication among interdisciplinary professionals is essential. To develop this glossary, CFNEI engaged with multidisciplinary subject matter experts who contributed to developing the terms list, writing associated definitions, and reviewing the multidisciplinary terminology/definitions. A consensus model was used to clarify ambiguous terms or terms with opposing definitions found in the literature and/or reference materials. This project served to create a resource that can be used to help bridge language related communication gaps and potential miscommunications associated with discipline specific terminology. Access to the Multidisciplinary Sexual Assault Glossary can be accessed through the FTCoE and CFNEI websites, and soon through a mobile application. In its current state the glossary contains more than 970 terms and over 40 medical illustrations. Anyone can suggest inclusion of terms for future updates to the Multidisciplinary Sexual Assault Glossary through an online feedback tool. The FTCoE and CFNEI will continue to update the glossary, import terms into the searchable index, and ensure that definitions are compliant with the FBI quality assurance standards to maintain consistency in federal documents. The glossary is currently available at *www.cfnei.com* and 2016 at *www.forensicCOE.org*.

TEITELBAUM'S COLUMN ON FORENSIC SCIENCE — HISTORICAL PERSPECTIVES —

Edward Oscar Heinrich (1881–1953)* — An American Pioneer in Forensic Science —

J. Teitelbaum

Forensic Science Library Services
Washington State Patrol
Seattle, Washington
United States of America

Edward Oscar Heinrich was an extraordinarily skilled criminologist who, almost single-handedly, helped to instill a more systematic and scientific level of criminal investigation in the United States in the 1920s and 1930s. Newspapers of his time referred to him as the "Wizard of Berkeley," the "Edison of crime detection", and the "Sherlock Holmes of America." Even now, he is held in the highest esteem by those who are familiar with his methodologies. Skip Palenik, one of the world's foremost forensic microscopists, wrote about one of Heinrich's famous cases and described the criminologist as "the first and likely the best ever American forensic trace analyst." [1]

> "One clue always is present after the commission of a crime. That one is the criminal's method. Every person in his every act in daily life leaves some impress of his method of procedure. So the criminal. Although he aims to keep his character and his identity his own secret, yet the mechanism of the crime, that is, precisely how it was committed, exposes his knowledge, his skill, and his habit."
> (E. O. Heinrich, as told to Eugene Block [2])

Heinrich was born in Clintonville, WI, but when he was nine years old, his family moved to Tacoma, WA, for the economic opportunities created by the newly constructed railroad lines. As a teenager, Heinrich worked in a pharmacy and became fascinated not only with the vials of pills and chemicals, but with what they represented. "I not only learned a great deal about pharmacy but much about people. A drugstore is a veritable laboratory in behavioristic psychology. I learned what people do in secret." Without having spent a day in high school or pharmaceutical school, he officially became a pharmacist by easily passing the state pharmacy examination. He soon became obsessed with chemistry and applied to the University of California at Berkeley, but he was informed that his lack of high school credentials prohibited his admission to college. Undeterred, he travelled to Berkeley, convinced a registrar to admit him as a special student in chemistry, and in 1908 received his degree in chemistry.

Heinrich found work as a chemist for the city of Tacoma, a position that involved him with casework for the local police and coroners. This work introduced him to the application of scientific techniques in the service of criminal investigations. Realizing that he would need more than chemistry to shed light on many of the cases he encountered, he began an intense course of study on ballistics, photography, fluid dynamics, handwriting, inks, and many other disciplines, working from books as well as devising his own experiments and methodologies.

His first major case involved an apparent suicide, but Heinrich quickly realized that the hole in the wall near the deceased woman's body was filled with dust and could not be the bullet hole that the police reported. He found a tiny fragment of lead imbedded in the wall, and he saw that the lead was dented on one side. Using a piece of string to calculate the angle from which the gun had been fired, he traced it to a point several feet away from the dead woman's body. Some faint bloodstains that someone had unsuccessfully tried to wipe clean provided yet another clue. When the shooter was later arrested, Heinrich was the star witness at the trial, and his reputation was established [2].

In 1916, Heinrich applied for the position of police chief in Alameda, CA, and was chosen for the job. He immediately installed new methods of criminal investigation, a new filing system for fingerprints that would make it easier to examine records for possible matches, and incorporated scientific techniques for analyzing evidence. An international case then came his way, and he would spend much of the next year studying Hindu dialects in an attempt to help the British and American governments try and uncover a conspiracy that involved Germany and India. He briefly took a city manager position in Boulder, CO, but, realizing that his true love was criminal investigation, soon returned to the Bay area and set up a laboratory in Berkeley.

> "The camera never lies but a camera in the hands of a liar is a dangerous instrument."
> (E. O. Heinrich, as told to Eugene Block [2])

Photography was an indispensable tool for Heinrich. By various accounts, he was the first to incorporate two cameras onto a stereoscopic microscope so that a resulting three-dimensional image of the subject could be obtained, a technique whose fundamental concept is still in use today. He used color-sensitive photographic plates to reveal evidence invisible to the naked eye, such as handwriting erasures, bloodstains on washed clothing, variations or alterations of ink pigment, etc. He also realized, even in the relatively early days of photography, that a camera could be used to manipulate an image. Speaking of using photography in court, he said:

> "The difficulty … lies in the fact that an uncorrected lens will distort things. When you go into court on the witness stand, using your photograph as an explanation of something that you have seen, and your lens saw it in a somewhat different way from the way in which your eye has seen that object, you are liable to divert the source of justice from its true path." [3]

In general, Heinrich seems infallible in the way that he is portrayed in articles, newspapers, and books, and, indeed, he is surely one of the most accomplished and innovative criminologists on record. The details of his participation in one extremely high-profile case, however, have only recently come to light, and, while the historical evidence is often murky and sometimes even nonexistent, his conclusions and courtroom testimony did not appear to hold up very well.

> The silent film comedian, Fatty Arbuckle, was one of Hollywood's biggest stars from 1909 to 1921. But on September 5, 1921, at a party in San Francisco's St. Francis Hotel, a 26-year-old actress named Virginia Rappe became seriously ill, was hospitalized, and died two days later of acute peritonitis caused by a ruptured bladder. Rappe's companion accused Arbuckle, who had been seen at the party with Rappe, of raping her and causing her death.
>
> Thus began a series of three murder trials for Arbuckle, from 1921 to 1922. Heinrich, who was already known as the premier criminologist in the United States, was called in to examine the hotel room, although he did not enter the room until 11 days after the September 5th party. The first trial ended with Heinrich being called as the star witness. He had the hotel door carried into the courtroom and announced that the fingerprints on the doorknob belonged to Rappe and Arbuckle, and that it appeared that his prints were pressed against hers as if he might be attempting to prevent her from leaving the room.
>
> During the second trial, which began on January 11, 1921, the defense not only brought in other fingerprint experts to challenge Heinrich's testimony, they presented a hotel maid who testified that she had thoroughly cleaned the doorknob of the room before Heinrich had examined it. Heinrich found himself in the unusual position of having his conclusions virtually negated. As for Arbuckle, the third trial, which began on March 13, 1922, ended in a verdict of not guilty, and the actor was cleared of all criminal charges. Unfortunately, his career was ruined, caused, in no small part, by the sensationalistic headlines of the Hearst newspapers over the course of the trials. One of the enduring mysteries of the Arbuckle trials is the absence of the court transcripts. The transcripts of the 2nd and 3rd trials appear to be definitively missing, possibly destroyed at some point, while the transcripts of the 1st trial were allegedly in the possession of an author, now deceased, who wrote a book on the Arbuckle case.

Despite the Arbuckle trial, Heinrich's reputation as a peerless criminal investigator was intact, and he was soon brought in to work on the case that would be his most lasting legacy and which has been written about numerous times as an example of the power of scientific investigative methodology.

> On October 11, 1923, a Southern Pacific Express train was heading south from Oregon to California when three men waved the train to a halt just as it was emerging from Tunnel 13, just north of the California border. Roy, Ray, and Hugh d'Autremont knew that the postal car carried $40,000 and they quickly attached explosives to the car, but they miscalculated the resulting force and the explosion destroyed the mail car and killed the mail clerk. In their panic, the brothers shot and killed two other train employees before escaping to a cabin three miles away that they had arranged to hide in.
>
> Near the train wreckage, investigators found a revolver, a pair of greasy, blue denim overalls, a DuPont blasting machine, and a knapsack soaked in creosote (to throw off their scent, it was later revealed). When they found a garage mechanic at a nearby town wearing similarly greasy, blue denim overalls, they arrested him for the murders and attempted robbery. When they realized that, other than the overalls, they couldn't connect him to the train heist in any way, some of the investigators suggested that Heinrich be called in to the case.
>
> After examining the evidence for several days, Heinrich astounded the investigators with a report that read: "You are holding the wrong man. The overalls you sent me were worn by a left-handed lumberjack accustomed to working around fir trees. He is a white man between 21 and 25 years of age, not over five feet ten inches tall and he weighs about 165 pounds. He has medium light brown hair, a fair complexion, light brown eyebrows, small hands and feet, and he is rather fastidious in his personal habits. Apparently he has lived and worked in the Pacific Northwest. Look for such a man. You will be hearing more from me shortly."
>
> The investigators soon learned how Heinrich had reached his conclusions … the left pocket was far more worn than the right, the 'grease' was fir pitch from the Pacific Northwest, a tiny piece of faded paper, which he treated with iodine vapor, was a receipt that listed the names Roy and Hugh d'Autremont, a strand of light hair that he identified as Caucasian, etc. Even with all of this information, which the investigators described as virtually a photograph of the suspects, it took them several years to apprehend the d'Autremont brothers, but they confessed to the killings and were imprisoned.

The career of Edward Heinrich looms large over the history of forensic sciences in the United States. His successful involvement in thousands of criminal investigations leaves a testament to a new approach to solving crimes, and his techniques became a template for law enforcement. Even his presentation style in court was consistent with his methods of investigation. Newspapers often commented that he presented information calmly and methodically and in a fashion that was easily comprehended by jurors. Heinrich died in 1953 at the age of 72, still working, still trying to coax just a little more information from the evidence.

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***** All photographs are in the public domain.

NEW BOOKS AND BOOK REVIEWS

New Forensic Science Books

Bearing Witness to Change: Forensic Psychiatry and Psychology Practice
E. Griffith, M. A. Norko, A. Buchanan, M. V. Baranoski, H. Zonana
CRC Press: Boca Raton, FL, US; 2016

Behavioral Evidence Analysis, International Forensic Practice and Protocols
B. Turvey, M. Esparza
Academic Press/Elsevier: Waltham, MA, US; 2016

Beyond the Bones, Engaging with Disparate Datasets
M. Mant, A. Holland
Academic Press/Elsevier: Waltham, MA, US; 2016

Biological Distance Analysis, Forensic and Bioarchaeological Perspectives
M. A. Pilloud, J. T. Hefner
Academic Press/Elsevier: Waltham, MA, US; 2016

Canine Olfaction Science and Law: Advances in Forensic Science, Medicine, Conservation, and Environmental Remediation
T. Jezierski, J. Ensminger, L. E. Papet (Eds)
CRC Press: Boca Raton, FL, US; 2016

Crime Scene Photography, 3rd ed
E. Robinson
Academic Press/Elsevier: Waltham, MA, US; 2016

Current Practice in Forensic Medicine, Volume 2
J. A. M. Gall, J. Payne-James (Eds)
Wiley-Blackwell: Somerset, NJ, US; 2016

Fingerprints and Other Ridge Skin Impressions, 2nd ed
C. Champod, C. J. Lennard, P. Margot, M. Stoilovic
CRC Press: Boca Raton, FL, US; 2016

Forensic DNA Evidence Interpretation, 2nd ed
J. S. Buckleton, J.-A. Bright, D. Taylor (Eds)
CRC Press: Boca Raton, FL, US; 2016

Forensic Epidemiology, Principles and Practice
M. Freeman, M. Zeegers
Academic Press/Elsevier: Waltham, MA, US; 2016

Forensic Evidence in Court: Evaluation and Scientific Opinion
C. D. Adam
Wiley-Blackwell: Somerset, NJ, US; 2016

Forensic Footwear Evidence
W. J. Bodziak
CRC Press: Boca Raton, FL, US; 2016

Forensic Medicolegal Injury and Death Investigation
M. H. Dudley
CRC Press: Boca Raton, FL, US; 2016

Forensic Pathology — Principles and Practice
D. Dolinak, E. Matshes, E. Lew
Academic Press/Elsevier: Waltham, MA, US; 2016

Forensic Psychology of Spousal Violence
M. Paulino
Academic Press/Elsevier: Waltham, MA, US; 2016

Homicide: A Forensic Psychology Casebook
J. Swart, L. Mellor
CRC Press: Boca Raton, FL, US; 2016

Human Body Decomposition
J. Haymen, M. Oxenham
Academic Press/Elsevier: Waltham, MA, US; 2016

Interpreting Evidence: Evaluating Forensic Science in the Courtroom, 2nd ed
B. Robertson, G. A. Vignaux, C. E. H. Berger
Wiley-Blackwell: Somerset, NJ, US; 2016

Materials Analysis in Forensic Science
M. Houck (Ed)
Academic Press/Elsevier: Waltham, MA, US; 2016

Munchausen by Proxy and Other Factitious Abuse: Practical and Forensic Investigative Techniques
K. Artingstall
CRC Press: Boca Raton, FL, US; 2016

Poisons: An Introduction for Forensic Investigators
D. J. George
CRC Press: Boca Raton, FL, US; 2016

Principles of Fire Behavior, 2nd ed
J. G. Quintiere
CRC Press: Boca Raton, FL, US; 2016

Real-World Crime Scene Investigation: A Step-by-Step Procedure Manual
G. Suboch
CRC Press: Boca Raton, FL, US; 2016

Unexpected Infant Death Autopsy Manual
E. Matshes
CRC Press: Boca Raton, FL, US; 2016

Book Review

Principles of Toxicology, 3rd ed
K. E. Stine, T. M. Brown
CRC Press: Boca Raton, FL, US; 2015
Reviewed by: *F. W. Fochtman, Duquesne University, Pittsburgh, PA, US.*

This third edition of *Principles of Toxicology* by Karen E. Stine and Thomas M. Brown presents a teaching text that is effectively organized to provide the student an overall understanding of the vast area of toxicology. There are 20 chapters of which 13 cover the basic and classic areas, one chapter (Chapter 13) that covers a relatively new area, ecological toxicology, and six "applications" chapters. The application chapters are on related areas that are identified later in this review. Many of the book's chapters end with a case study that exemplifies the principles covered.

The book starts with the basic concept of determining how toxic something will be and how to assess the risk of exposure. The first chapter, titled Measuring Toxicity and Assessing Risk, includes information about toxicity testing, identifying a hazard, and evaluating human exposure and risk management. It is a brief chapter but amply introduces the concepts of exposure to chemicals that can produce toxicity in man. The chapter ends in a case study that illustrates the concept of risk to exposure. Toxicokinetics is the title of the second chapter. The chapter explains the connection between toxicology and the science of pharmacology and pharmacokinetics. The principles of pharmacokinetics involve the movement of drugs into, through, and out of the body. These same principles are applicable to toxic exposures where substances are absorbed into the blood, distributed to organ systems, metabolized, and excreted from the body. The mathematical models for concentrations of chemicals absorbed and excreted from the body are adequately explained. A determining factor in toxicokinetics is how the process of metabolism affects the clearance of toxic substances from the body. Chapter three, titled Biotransformation, covers metabolism. Suitable and relevant examples of phase I and phase II routes of biotransformation are presented. Polymorphisms of oxidative enzymes are discussed and examples of bioactivation and detoxification are provided.

Toxicity mechanisms are introduced in chapter four, Cellular Sites of Action. This chapter includes not only how toxic substances combine with cellular sites, but identifies the various receptor sites where ligands form and the resulting actions. The effect of toxic substances on lipids and nucleic acids as well as programmed cell death and repair is included. The case study at the end of the chapter features a mechanism of action for a class of drugs that can result in multiple adverse effects. Chapter five is titled Genomics and New Genetics in Toxicology. A discussion of the Human Genome Project is followed by how genetic comparisons of various organisms and manipulating genetic material provides insight into toxic mechanisms. The terms toxicogenomics and pharmacogenomics are presented and how they are associated with metabolomics and the value of systems biology and systems toxicology. A case study features directions for using GenBank and other genomic online tools. A chapter on carcinogenesis includes epidemiology, environmental factors, and genetic factors that are involved with cancer etiology. A discussion of theories of cancer formation and progression is comprehensive including initiation and promotion as well as identifying function of oncogenes and tumor suppressor genes. The chapter includes how the body protects against cancer, information regarding testing compounds for carcinogenicity, recognition of the complex nature of cancer, and future research questions. A quantitative structure-activity relationship (QSAR) approach to predicting carcinogenesis ends the chapter.

A reproductive toxicology chapter covers the basic processes of cell division for both meiosis and mitosis as well as functions of the male and female reproductive systems. Illustrations are informative and the discussion of physiological mechanisms brief but very comprehensive. The chapter continues to present the effects of toxicants on reproductive systems and embryonic development. Included are embryogenesis, developmental genetics,

mechanisms of teratogenicity, and testing for reproductive and developmental toxicity. The chapter's case study is about the notorious teratogen thalidomide.

Chapters 8, 9, 11, and 12 cover the target organs of the respiratory system, the cardiovascular system, the liver, and the kidneys. Each chapter includes a brief anatomical and physiological discussion of the organ system that is comprehensive enough relative to the damage of target organ toxicants. The respiratory system chapter includes defense mechanisms, responses to toxicants, lung cancer, and other prominent lung diseases. A discussion of inhalation studies is included. The cardiovascular chapter includes the effects of toxicants on the heart, the vascular system, and the blood. Effects on the conduction system, coronaries, and the myocardium of the heart are presented. Toxicants that cause hemorrhages, anemia, and hemolysis as well as those that affect hemoglobin are covered. The chapter on hepatic toxicology covers toxicant-induced liver injury that includes fatty liver, cholestasis, cirrhosis, and necrosis. Acetaminophen and ethanol liver toxic mechanisms are included. The response to injury by the liver and evaluating liver injury and treating disease is discussed. Damage from toxicants to the kidneys is covered in the Renal Toxicology Chapter. Toxic agents are identified along with the specific functional unit of the kidney they damage. Included is information for measuring kidney function and how the kidneys compensate once damaged.

A chapter on neurotoxicology (10) reviews the function, anatomy, and physiology of the nervous system, including a discussion of the central nervous system (CNS) and the autonomic nervous system (ANS). Physiological mechanisms of typical neurotransmitters and where they are found in the nervous system are included in descriptions of the effects of various neurotoxicants. Identification of amino acid neurotransmitters and neuropeptides and how they are involved in toxic mechanisms are included. Mechanisms of toxicity involving receptors and mechanisms of direct action on neurons that result in damage or interfere with electrical signal propagation are discussed. Methods for studying neurotoxicology are included at the end of the chapter and a case study featuring botulinum toxin is informative.

Chapter 13, titled Immunotoxicology, provides a review of the immune system, nonspecific defense mechanisms, and the development of specific defense mechanisms in response to exposure to antigenic substances. Substances that produce toxicant-induced allergies, autoimmunity, and immunosuppression are presented. The chapter ends with a discussion of AIDS and antiviral drugs and a section on methods for studying immunotoxicity.

A chapter on ecological toxicology focuses on assessing the effects of toxicants on the population, community, and ecosystem levels and how they can be measured. Included is information on population genetics, natural selection, and population growth. Effects of toxicants at both the community level and at the ecosystem level are discussed. Examples of ecosystems that are vulnerable to toxicants include marine, freshwater, and terrestrial ecosystems. Climate change is also discussed. The chapter ends with ecotoxicological testing methods and a case study involving plastic debris in the marine environment.

The last six chapters in the book are titled "Applications" with the following subtitles: Pharmacology and Toxicology, Forensic Toxicology, Environmental Toxicology and Pollution, Radiation, Food Safety, and Toxins. Each of these chapters provides basic descriptive information about the area and, where relevant, identifies specific toxicants, toxic mechanisms, and regulatory information. Throughout these chapters there are references to target organ chapters and mechanistic chapters that are applicable in order to provide a comprehensive understanding of toxicity.

An appendix provides a list of selected toxicants that includes approximately three dozen recognized substances that pose a risk of toxicity upon exposure to humans. The listing includes the chemical formula, physical properties, sources and how used, and typical toxic effect and LD_{50} where available.

Throughout most of the chapters in the book there are strategically placed inserts featuring a word or substance and a note to "see also:" indicating one or more topics in other chapters that complement or explain further the information expressed in the current chapter. Following these references appears to be very useful in supporting or adding to the information in a manner where it would not have to be repeated in the current chapter and allows the student to have a better understanding of the topic. A student may also use the book as a reference source for a specific topic by following the "in text" references to gain a full understanding of the topic.

In summary, as expressed by the authors, I found the book to be a comprehensive textbook for a first course in toxicology at the undergraduate or beginning graduate level. There are some areas, particularly in the "applications" chapters, that would benefit from greater in-depth discussions, but overall the text adequately covers at the basic level the science of toxicology. It is important to note that each chapter has an extensive bibliography and should one wish to study toxicology in greater depth many of the references listed would provide what is necessary. This book can be a valuable resource for forensic practitioners.