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INTERVIEW

Barry Logan, a prominent toxicologist and forensic analytical chemist, kindly spoke with BrJAC about his research into drugs of abuse, the legacy and inspiration for future generations

Barry Logan PhD, F-ABFT, Chief Scientist NMS Labs, and Executive Director at the Center for Forensic Science Research and Education (CFSRE)
Adjunct Professor at Thomas Jefferson University, Forensic Toxicology Program

Dr. Barry Logan is a world leading forensic toxicologist currently serving as Chief Scientist at NMS Labs, and Executive Director at the Center for Forensic Science Research and Education (CSFRE) in Willow Grove, Pennsylvania. He was born and completed his undergraduate and graduate education in Glasgow, Scotland, completed a postdoctoral fellowship at the University of Tennessee in Memphis TN, then served for eighteen years as State Toxicologist for the State of Washington, with an appointment at the University of Washington in Seattle. For nine of those years he also served as Director of the Washington State Crime Laboratory System, which provided services in forensic biology, toxicology, chemistry, document examination, serology, DNA analysis, firearms and crime scene support. In 2008, Logan joined the United States leading forensic toxicology and chemistry reference laboratory – NMS labs – in Pennsylvania to direct their toxicology services. In 2010 he founded the CFSRE and in 2017, established www.NPSDiscovery.org the leading clearing-house for the dissemination of newly emergent drugs in the United States.

He has over 150 publications and 600 presentations in forensic toxicology and analytical chemistry, including work on the effects of methamphetamine, cocaine and marijuana on drivers, and drug caused and related death. His recent work has focused on the analytical and interpretive toxicology of novel psychoactive substances (NPS). Dr Logan's other appointments include Executive Director of the Robert F. Borkenstein course at Indiana University, and academic appointments at Arcadia University, and Thomas Jefferson University in Philadelphia. In recognition of his work and contributions, Dr. Logan has received numerous national and international awards, and in 2013-14 served as President of the American Academy of Forensic Sciences (AAFS). A recent bibliometric analysis of the impact of the world's forensic scientists, positioned him as the leading contributor to research in the field of forensic toxicology in the United States, and sixth in the world.

In the last ten years Dr. Logan has had extensive involvement with forensic scientists in Brazil, hosting graduate students from the Federal University of Rio Grande do Sul, University of São Paulo, and University of Campinas at his laboratory in the United States, and visiting scientists from

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the Federal Police and State Crime Laboratories. He has presented multiple times at Interforensics, ENQFor, and Brazilian Academy of Forensic Sciences meetings. The CSFRE supports participation of young scientists from Brazil in the AAFS meeting and a reciprocal opportunities for young US scientists to attend Interforensics.

Which factors influenced your education? When did you decide to study chemistry? What motivated you? How was the beginning of your career?

I grew up in western Scotland outside Glasgow in the 1960's and 70's and remember being very excited about my first chemistry classes in secondary school, and the lab aspects of it. The idea of learning by doing experiments, discovering things, putting individual results together to answer bigger questions was very appealing to me. That's eventually what led me to an interest in forensic science. I enjoyed chemistry much more than my other science classes, physics was too mathematical, and biology was lacked the finality of a conclusion. I especially liked the idea of using chemistry to solve problems, and figure things out and remember reading an article in a school science magazine, called "Detectives in White Coats" about forensic science. I cut it out and took it to my career teacher who told me I'd have to go to medical school to get into that field. Undeterred, I read whatever I could about forensic science, not so easy before the internet, and eventually discovered a neighbor, Keith Eynon, who worked for the Strathclyde Police Forensic Laboratory. He told me chemistry was the way to go, so I applied to chemistry degree programs and attended Glasgow University, earning a bachelor's degree in chemistry. I really enjoyed my chemistry courses, both the analytical aspects and the theoretical. I enjoyed quantum chemistry, group theory, and chemical physics too, but the math was too off-putting for me. My interest in analytical chemistry was reaffirmed by the organic chemistry labs where we had to characterize the products we synthesized based on color reaction, UV and NMR data. One of my professors, Charles Brooks, established the first Gas Chromatography-Mass Spectrometry (GCMS) Unit in a UK University with a grant from the Science Research Council, and one of his graduate students, Bob Anderson, was hired to implement the technique at the Department of Forensic Medicine and Science at Glasgow University.

The idea of learning by doing experiments, discovering things, putting individual results together to answer bigger questions was very appealing to me.

After graduating with my chemistry degree, I interviewed in the forensic medicine department for a PhD scholarship. It was a terrible interview. I was so very nervous that I sweated profusely through the whole interview. At one point the interviewer handed me a box of tissues to dry my face. In spite of that performance I was offered the position and spent the next four years working on my PhD. My first forensic toxicology assignment was to collect urine from the greyhounds racing at Shawfield Stadium and test it for doping drugs. I followed the dogs around with a stainless-steel bowl until they were ready to provide a sample. We used thin layer chromatography for alkaloids, UV-visible spectrophotometry for barbiturates, and gas chromatography with nitrogen phosphorus detection for other drugs. GCMS was not used for routine casework at the time it was too cumbersome, subject to breaking down, too expensive, and computers were only just being interfaced with analytical instruments. My PhD program introduced me to postmortem toxicology also for the Procurator Fiscals office, and I went to court to see my boss John Oliver testify in a drunk driving case. That experience confirmed for me that I wanted to be a forensic toxicologist. I headed off to the United States for a postdoctoral position at the University of Tennessee in Memphis, under David Stafford, a former graduate student of Harold McNair an early pioneer of GC in forensic toxicology in the United States.

What has changed in the student profile, ambitions, and performance since the beginning of your career?

Academia has changed markedly since I went to University, so I see many differences. Universities are a business now, due to less support from governments. It seems to me that being a student today is less fun than when I was at school. Getting an education is a rite of passage, and a requirement for getting a good job, as opposed to learning for the love of learning. After my first year, almost every class I took was a chemistry class and they were illuminating – even areas unrelated to where I made my career, like quantum chemistry and group theory. I enjoyed every minute of my undergraduate degree, and the friendships and connections I made; I hope today's students still take the time to enjoy their time. As students, it was much more up to us to keep up and meet our commitments. I think we respected (and feared) our teachers a lot more than students do today. All our professors were researchers first, and teachers second, and their academic success was based more on their accomplishments as a researcher than as a teacher. Today, there is much more emphasis on student success, and academicians are recognized and rewarded for their teaching activities which is much better for the students. Universities are run a lot more like businesses today which is both good and bad. Students often feel that they are customers of the institution, and that the institution owes them an education. I always talk about earning my degree from Glasgow University, not just receiving my degree. There is more accountability today for how both teachers and students spend their time, but less time for pursuing more esoteric, risky and exploratory avenues.

What are your lines of research? What work are you currently developing?

My career took me from my PhD program to a postdoctoral program which was a great track. A postdoc gives you the opportunity to take the lessons you learned from your doctoral program from how to be a scientist, how to perform someone else's research, find what topics interest and fascinate you, explore your own ideas, make your own mistakes, critically evaluate your own theories and perspectives, to forming your own philosophy of your science. My experience as a postdoc gave me a much greater love for research than I got from my PhD program, and a lot more confidence in myself. After my postdoc, I took a path within forensic toxicology that was more service oriented and included the application of science to answering questions in court and with medical professionals about cause and manner of death, addiction, poisoning, overdose, homicide, and impairment. I spent ten years working as the State Toxicologist for the State of Washington in Seattle in the US pacific northwest. The focus at this time was documenting the effects of various drugs on the appearance and behavior of suspected drug impaired drivers, examining, the behavioral observations, driving effects and toxicological findings. I produced over 30 papers on drug driving related findings during this time. Even in that service role, which was extremely rewarding intellectually, and from a community service point of view, I recognized the value of more applied research in learning from real world cases and applying that learning to the resolution of future cases. I started publishing case series and looking for patterns and trends in drug related deaths and impairment, especially in drug-impaired driving. Generating reference data for the interpretation of drug related death is an incredibly important resource for practicing forensic toxicologists and is easily achievable by young scientists in the course of their routine casework. The application of analytical tools and strategies to forensic casework is a unique opportunity for scientists working in this more applied field to contribute and grow. I continue my work on the role of drugs and alcohol in impaired driving, and have recently focused on the creation of guidelines for more consistent best practices by forensic toxicology laboratories, to ensure better data on this significant societal problem, leading to better policies and strategies in reducing alcohol and drug impaired driving.

My experience as a postdoc gave me a much greater love for research than I got from my PhD program, and a lot more confidence in myself.

My current focus on emerging novel psychoactive substances (NPS) started in 2010 with the advent of the research chemical or designer drug movement. I remember attending a conference in Glasgow in 2009 and sitting next to someone at the conference dinner who I hadn't met before who told me about "Spice"- a

new drug showing up in drug seizures. This was very interesting as besides the traditional drugs of abuse, and a slow but steady pipeline of new therapeutics, there was relatively little turnover in new drugs in forensic casework. “Spice” turned out to be the first of the synthetic cannabinoids, JHW-108 and HU-210, drugs that had been pirated from the drug development research literature and synthesized for distribution on the street as “Legal Highs”, novel substances for which there were at the time no controls, allowing them to be widely sold and distributed openly at gas stations, and convenience stores as novelty products. By this time, I was working at NMS Labs, a commercial independent reference laboratory in Philadelphia PA. In the private sector innovation is especially important in order to provide a service that adds to the resources available to the country’s public sector laboratories. We began developing and offering tests for these new “designer drugs”, which later were renamed as novel psychoactive substances (NPS). This included the “Bath Salts” novel stimulants and hallucinogens in the amphetamine, methylenedioxyamphetamine, and pyrovalerone classes, many more synthetic cannabinoids, novel opioids, including many deadly fentanyl analogs, and novel illicit benzodiazepines.

In addition to my work as Chief Scientist at NMS Labs, I was also invited by the company’s owners, Eric and Michael Rieders, to lead their non-profit Foundation, the Fredric Riders Family Foundation and its Center for Forensic Science Research and Education (CFSRE), after their father Fredric Rieders Sr. At the Foundation, I created the program NPS Discovery (www.npsdiscovery.org), an initiative designed to conduct focused research on the identification, surveillance, and monitoring of new substances, and provide early identification and notification of their penetration in the United States Drug Supply. Once identified, the program characterizes and studies to toxicology, chemistry and epidemiology of the drugs, including the preparation of public health alerts, trend reports, new drug monographs, and publications on the analysis, quantitation, metabolomics, and receptor binding and functional activity of these new drugs. This enables the program to provide an informed early warning system to public health and safety agencies in the United States to promote data collection, analysis, harm reduction, interdiction, supply reduction, and scheduling to better monitor and control NPS. NPS Discovery has identified over 75 new substances in the United States in the last three years. This work continues apace, and it has been a great opportunity for our energetic young scientists, including several from Brazil, to contribute to this knowledge.

For you, what have been the most important achievements in the analytical research field recently? Could you briefly comment on recent advances and challenges in analytical chemistry considering your contributions?

In the 1990’s and 2000’s forensic toxicology became very routine. The focus turned appropriately to improving quality, validation, and reliability of the results produced in forensic laboratories. Instrumental platforms had the levels of sensitivity required for detection of most drugs at toxic and therapeutic concentrations, a few new substances were launched each year from the pharmaceutical pipelines, but at a rate where it was easy to keep up. Attention turned to method improvement, to accreditation, better documentation of methods and procedures, and more validation of methods. More laboratories also began determining measurement uncertainty for assays that had critical cut-off points, such as drug impaired driving cases in states where there were legally adopted concentration limits.

Towards the end of the 2000’s more laboratories began to have access to LCMSMS, whereas before, GCMS was the most common technique. LCMSMS allowed for more rapid sample preparation and eliminated the need for chemical derivatization of many polar compounds and metabolites which had been required for GCMS. LCMSMS is best suited to confirmatory quantitative procedures, and GCMS remained the choice for screening, until the increase in availability of economical high-resolution mass spectrometry (HRMS) platforms in the 2010’s.

HRMS has been a revolutionary technique for drug screening and confirmation, as it allows the identification of unknowns based on measurement of the accurate mass of the parent compounds and their fragments, allowing both chemical formula determination and structural determination – especially important for the identification of novel emerging drugs and NPS. In addition, HRMS allows for the prospect

of retrospective data mining of non-targeted acquisition data sets to be able to look back in time for the presence of novel compounds discovered today, in archived data without having to retest those samples. This has greatly enhanced NPS Discovery's ability to do trend analysis of the life cycles of new drugs from the first case through their proliferation, plateau and decline, and the appearance of successor compounds.

There are several meetings of chemistry experts that take place around the world. What is the importance of these meetings to the development of the area?

The first of the five pillars of NPS Discovery is Intelligence gathering. This phase of an effective new drug early warning system is understanding the universe of compounds that may be at large in the world, and rapidly identifying those that are rising to the level of a public health threat. Key to this Intelligence phase is our communication with our colleagues around the world. The scientific staff of the CFSRE attend scientific meetings in the United States and internationally to network with colleagues, create new collaborators, identify funding resources and breaking down international barriers. During 2020 and the impacts of COVID-19, we learned the hard way how much opportunity we lose to make these new connections when we can't travel to meetings or meet face to face. We have found ways to make online meetings and virtual meetings work for keeping up, for checking status, for sharing information, but they are not well suited to getting to know new people, to build the personal relationships and trust relationships that come from talking at a break, going to dinner, or sitting in a bar after a long day of presentations.

Dr. Logan at the 57th Annual Meeting of TIAFT 2019 in Birmingham, UK.

Conferences in the field of forensic toxicology that I have found to be the most dynamic and fruitful are the multidisciplinary meetings like the American Academy of Forensic Sciences, and the American Society for Mass Spectrometry, these are great for the cross-pollination of ideas between fields or areas of analytical science. Subject matter specific meetings are also critical, because of their focus and the strong relevance of the content. My favorites are the international meetings, since its great to be able to travel to a new location, to broaden your horizons, but also to hear from people you wouldn't typically hear from in your own backyard. I enjoy attending The International Association of Forensic Toxicologists (TIAFT) meetings because of the large number of academic programs represented there, more so than in the United States. I have attended several conferences in China and Brazil, and although I speak no Chinese or Portuguese, have been amazed at the capabilities of Google translate to read posters and communicate with many more people than I would ever do if not there in person.

No scientific discipline flourishes when people work in isolation, and collaborations are key. Scientific professional groups and their conferences help facilitate that.

No scientific discipline flourishes when people work in isolation, and collaborations are key. Scientific professional groups and their conferences help facilitate that. I'd encourage all young scientists to find a sponsor, join an organization, volunteer, listen, participate. Never be afraid of asking a senior professor or department chair to support your application, without exception, its an easy thing to do, and may open more channels for communication with your sponsor.

Do you believe that the current graduate programs produce quality researchers in the field of analytical chemistry? Is there need for further integration?

Research is a challenging assignment and not every scientist is cut out for it. As part of an undergraduate or Master's degree program if you are lucky enough to have research exposure, enjoy it for the lessons learned about how difficult it is, and to develop an appreciation for those who choose it as a career. From my perspective, research teaches you about the scientific method, hypothesis testing, critical thinking, time and resource management, and appreciation for bias and uncertainty. All are valuable lessons for every scientist. The research experience may also benefit the academic institution, the student's ultimate employer and the profession, so should be viewed as a means to an end in higher education as much as it is an end in itself.

To be properly prepared for research, I believe that you need either the discipline of a doctoral program, with a number of years dedicated to your research project, or a strong mentor and peers who teach you essentials of the scientific method, the patience to get things right, the skills in critical analysis of your work, and the writing skills to communicate it to your peers. I think the latter path to research is actually more important than the former. I also highly respect scientists for whom research is a subsidiary endeavor to their more routine work. It speaks to their commitment to discovery, and their passion for their science, and always adds value to the field.

Research is a calling, and especially so in forensic toxicology. It is important that researchers have a deep appreciation for the field. In addition to the applied research that falls out of learnings from more routine experience in service work or casework, there is always a need for people who are inspired to follow big ideas, which sometimes succeed and sometimes fail, but that drive forward knowledge and discovery. To dedicate your professional life to that is a calling.

Dr. Logan and his long-time collaborator Fran Diamond.

For you what is the importance of the support of funding agencies for the scientific development of the country?

Research and exploration cost money. There is no way around that. Not every research project results in a discovery, or a product, or an application, but perhaps it presents an opportunity to avoid dead ends or fruitless approaches to solving forensic problems. Research funding is a luxury when countries or governments have other human rights and basic human needs to meet, at least in degree. However, nurturing your country's academies, seeding today's and tomorrow's scientists and researchers, keeping your scientific community up-to-date with the world's technologies and new discoveries is an investment in the future of humankind, and in the advancement of knowledge. Research funding should be consistently

a percentage of a country's gross domestic product, proportionate to what its economy can support, and viewed as an investment its future. Of course, countries need to prioritize where that money should be spent, but investment in scientific support for criminal justice, social justice, and civil society all depend on the resources and objective information that forensic sciences provide to the prosecutors, the defense and the courts, and must not be overlooked. At the CFSRE we seek out like-minded collaborators and invest our own resources in developing proof-of-concept studies to collect pilot data that can support robust and compelling grant applications. These give the funders confidence in our ability to execute and follow through on our proposed objectives.

What sort of a career could someone expect in the field of analytical chemistry could pursue? What advice would you give to a newcomer to this area?

I love the fact that the forensic sciences are both a career in their own right, but also an opportunity to attract young scientists into careers in science in general, and a gateway to other careers in pharmaceutical sciences, environmental sciences, law and medicine. Becoming a scientist is hard! It involves learning the language, concepts, principles, scientific method, technology, and the history of science. Analytical chemistry introduces young scientists to the fundamentals of chemistry, the nature of matter and materials, measurement science, identification. Analytical chemistry services so many other aspects of synthetic, industrial, and forensic disciplines, and should be a part of all undergraduate chemistry curricula.

How would you like to be remembered?

Very few scientists are lucky enough to discover or invent something that has a multi-generational impact, so I hope I have a pragmatic expectation about my legacy. I think that as scientists the opportunity we have to influence beyond what we accomplish in our own work, is to inspire the people closest to us in our agencies, institutions and professional organizations – our students, our young scientists, and our peers. I hope a few of my presentations or publications, or projects I started have inspired some reflection and inspiration to the current and upcoming generations of people working in my field, but mostly I would like to think that there is an echo of my perspective that shows up in the work of my graduate students, or mentees, and that they in turn can accomplish more than I could in the time allotted to me.

Dr. Logan with a group of high school students and mentors in the summer science program at the Center for Forensic Science Research and Education – CFSRE.