

## Just Forensic Toxicology and Professional Partnerships

**Introduction** [00:00:05] Now this is recording RTI International Center for Forensic Science presents Just Science.

**Voiceover** [00:00:18] Welcome to Just Science, a podcast for justice professionals and anyone interested in learning more about forensic science, innovative technology, current research, and actionable strategies to improve the criminal justice system. In Episode seven of our Strengthening the Forensic Workforce Season, Just Science sat down with Dr. Karen Scott, an Associate Professor at Arcadia University, and Dr. Jarrad Wagner, a Professor at Oklahoma State University, to discuss research collaborations, keeping on top of the dynamic drug landscape encountered in forensic toxicology case work. One of the requirements of FEPAC accreditation is that programs maintain partnerships with external collaborators such as forensic science laboratories and professional organizations. This is especially important for rapidly evolving disciplines like forensic toxicology, where there's a constant influx of new drugs and analytical challenges, such as lack of available reference standards and complex biological matrices. Because of these issues, students and researchers at universities and practitioners in crime laboratories must work together to develop new techniques for novel drug detection and analysis in real time. Listen, as long as Dr. Scott and Dr. Wagner discuss their FEPAC partnerships, ongoing research efforts, and the importance of hands-on learning in their forensic toxicology programs. This episode is funded by the National Institute of Justice's Forensic Technology Center of Excellence. Here's your host, Gabby DiEmma.

**Gabby DiEmma** [00:01:37] Hello and welcome to Just Science. I'm your host, Gabby DiEmma, with the Forensic Technology Center of Excellence, a program of the National Institute of Justice. This season, Just Science has been discussing forensic science programs and NIJ funded research at universities accredited by the Forensic Science Education Programs Accreditation Commission or FEPAC. Here to guide us in our discussion is Dr. Karen Scott, an Associate Professor, Forensic Toxicology Consultant and Director of the Master of Science in Forensic Science Program at Arcadia University and Dr. Jarrad Wagner, a Professor and Director in the Oklahoma State University School of Forensic Sciences. Karen, Jarrad, welcome. It's great to have you on the podcast.

**Karen Scott** [00:02:18] Thanks, Gabby. It's great to be here.

**Jarrad Wagner** [00:02:20] Thanks. It's nice to be here.

**Gabby DiEmma** [00:02:22] So, Jarrad, I know you have been on the show before in a previous season, but could you introduce yourself and tell us a little bit about your professional background for our audience?

**Jarrad Wagner** [00:02:32] So I'm a Professor at Oklahoma State University and I'm the Program Director for our FEPAC accredited program. Before this I was with the FBI. I was a chemical weapons specialist there and prior to that I was a professor at Fresno State University and I was a forensic scientist in the Orange County Sheriff's Department where I did postmortem antemortem toxicology, so human performance as well as post mortem work. So my Ph.D. is in actually environmental toxicology and then I have undergraduate degrees in biology and chemistry and just got quite a bit of different law enforcement experience and also forensic science experience really across state, city and county and federal government.

**Gabby DiEmma** [00:03:14] And Karen, you have been my research mentor and friend for years, but for those listening who might not be familiar with you and your role at Arcadia University, can you tell us more about your professional background?

**Karen Scott** [00:03:26] So I'm originally from Scotland. I did my undergraduate degree at the University of Strathclyde, which is in Glasgow in forensic and analytical chemistry. I then moved across the city to the University of Glasgow, where I did my Ph.D. in forensic toxicology. Following that, I moved to Japan, where I did a two-year post-doctorate in hair testing under the tutelage of Yuji Nakahara. So I was two years in Tokyo doing hair analysis, looking at incorporation, mainly of the benzodiazepines into hair. Following that I moved back to the UK, to Cambridge and I started my career in academia at Anglia Ruskin University. I was there for seven years. I then moved back into the field of forensic toxicology at the University of Glasgow. I worked at the Department of Forensic Medicine and Science for five years. That position was a dual position, so I was a forensic toxicologist doing postmortem forensic toxicology mainly. But I also set up the Masters of Science in Forensic Toxicology there. Stayed in academia prior to coming over to the United States, where I've been the Director for 10 years at Arcadia.

**Gabby DiEmma** [00:04:46] So both of your universities have excellent FEPAC accredited forensic science programs. Can you tell us more about your programs in general? And then I'd love to hear more about the toxicology tracks in particular, since I know that both of your areas of expertise.

**Jarrad Wagner** [00:05:01] Yeah so actually I'm the Program Director for the entire program. That's the FEPAC accredited program at Oklahoma State University and we've been mainly online. Obviously, the research needs to be done, but we have some really neat distance learning and always have. And we've had to be flexible with our online courses versus our in-person courses in order to meet those very stringent FEPAC requirements. So I am the track lead, we call it, for forensic toxicology and also forensic chemistry, which we'll talk about in a bit. Probably some of the NIJ funded research I have is more related to forensic chemistry. But if you think about it as a larger problem set, it's for me looking at toxicology, there's the chemistry of making the drug or the toxin and then there's characterizing that product and looking at, well, how was it made and what features are there that tell us how it was made and what's present that can be harmful. And then there's looking at biological materials and trying to assess what's present and how those compounds have created injury or how they affect human performance. So as a whole, that's the way I look at forensic toxicology and forensic chemistry is kind of blending together. So in a way, I'm kind of a generalist now. Our program is 32 credits, basically, so 32 semester hours, which is we had reduced it from 39 and it's very difficult to get all of those topics in so there's not a whole lot of room for electives and we're a fairly large program as well.

**Karen Scott** [00:06:35] So the program at Arcadia has four tracks. We have chemistry, trace evidence, biology and toxicology. And students actually get to study all four of those tracks while they're in the program through the courses that they take. However, they do get to specialize through their research opportunities and their internship opportunity. The internship actually takes place primarily through our partnership with the Center for Forensic Science Research and Education. We have a strong partnership with that laboratory, which is close by to Arcadia in nearby Willow Grove.

**Gabby DiEmma** [00:07:11] In your opinion, what are some of the advantages of FEPAC accreditation both for your university and your students?

**Karen Scott** [00:07:18] So FEPAC keeps the programs accountable. We are going through our FEPAC accreditation right now and that is a lot of paperwork. So we are having to take an inward look at where we're at with regards to the support that we get from the university. We have a look at what our curriculum looks like. We look at what support is available both within the program from the university. We look at the services the university provides every year. We're looking at the feedback that the students provide to us. We look at where our students go and once they graduate from the program. So students such as yourself, Gabby, obviously you're one of our successes. Like I say, they keep us accountable. They're making sure that when students are coming into the program that they're suitably qualified. Whereas without that, you're running the risk of having a substandard program that isn't meeting the needs for the industry itself.

**Jarrad Wagner** [00:08:23] I think the main advantage to us for FEPAC has been name recognition for students. So if someone's interested in forensic science and they go to look at programs, because of the American Academy's Forensic Education Programs Accreditation Commission, they go to that FEPAC site and they can look and see, Oh, well, Oklahoma State University has a program and I think that's been very good, especially as we were growing. The FEPAC, the accreditation itself, I think obviously there's a lot of requirements for tracking data and keeping high quality within the program and really whether we're FEPAC accredited or not, if we don't have students out there that are working in the field and building our reputation as producing great students, then none of it really matters. I'm very pleased that all of my students I mean, every one of my students is out working in the field. They're either in a clinical lab or a forensic lab and they love what they do and people that have them will typically ask if I have more of them.

**Gabby DiEmma** [00:09:23] And so you mentioned research and your research collaborators, so I'd be interested in hearing more about the research that you do and those you collaborate with and how has the National Institute of Justice played into those research opportunities or shaping your program?

**Karen Scott** [00:09:40] So we have collaborations with other local universities. You yourself are very familiar with that. So one of our collaborators is Rutgers University. Your own research through the Arch Street Project is with Rutgers University. We have several of the offices of Chief Medical Examiners who we collaborate with. We collaborate with AFMES in Dover, Delaware. We have collaborations with the Center for Forensic Science Research and Education and NMS Labs. They're one of our largest collaborators. I mentioned previously that we have a partnership with the Center in Willow Grove, and that's our FEPAC relationship requirement for FEPAC. Based on FEPAC, we obviously have the requirement that each of our research projects has an external person. So every student researcher has to have someone unaffiliated with the program on their research committee. So whether that be somebody who works at the Center or somebody who works at NMS Labs, it should be somebody who is an expert in that particular research area. Just this past year, we've done some hair research projects and some of the casework that I'm involved with is actually over in New Zealand and I do a lot of family court work over there. So one of the student research projects where we've been evaluating different anatomical regions for hair testing, we actually have a collaborator over in New Zealand who's been working with the student on her research project. So we have some international collaborators as well as those locally within the United States. So some of the research ideas that we have obviously come from initiatives that stem from the NIJ and some of the student research projects for next year are looking at drug stability, for example, for some of the NPS drugs. And we work as I mentioned, we work

very closely with the Center for Forensic Science Research and Education, and we have some joint research projects with them looking at - and we look to things like NPS Discovery to determine which types of drugs require to be evaluated much more urgently than others. And obviously, NPS Discovery is one of those NIJ initiatives. Also, my most recent faculty hire, Dr. Fabio Oldoni, is very involved with NIJ initiatives. He's a forensic biologist and is looking at some of the more novel methods of determining micro haplotypes and newer ways of evaluating DNA sequences.

**Jarrad Wagner** [00:12:40] So the National Institute of Justice has been really important for everything we've done at Oklahoma State University. They've funded our forensic biology DNA projects. The former chair, Dr. Robert Allen, who's going to be retiring soon, is still working through a couple of different projects related to RNA in biological specimens to look at - trying to determine where that biological material was deposited and I have some support now related to fentanyl so basically what we're doing is I'm working with the CDC NIOSH. It's occupational safety and health, but they are really very good at respiratory issues and toxicology and we're working together on a fentanyl problem. So we're looking at how fentanyl is aerosolized during the process of field testing and what sorts of exposures police officers have while field testing and while responding to these calls and we're basically trying to get at how these materials are affecting them. And that's an NIJ sponsored project that it is through CDC NIOSH, but we also have EPA involved. So they're working on new types of decontamination. And what's been great is that we've been able to develop analytical techniques around fentanyl. We can look at fentanyl on surfaces, we can look at fentanyl in the air. In fact, I just received an acceptance for a paper in Journal of Forensic Sciences related to fentanyl characterization. So it's really exciting because NIJ saw that it's a large problem that's affecting a lot of people in public safety, but no one was taking a systematic approach to actually characterize the exact amounts of exposures and what's likely happening. And so I'm excited about the work because it's going to put some data behind something that we're seeing. We'll see officers have issues on camera, but there's a lot of toxicologists that are like, wow, that's just psychosomatic. Well, it's important for us to know what they're being exposed to and to really answer the entire question. And we can't do that without doing the work. And it does help that I have the necessary licensing there. We have DEA licensing for research related to these compounds. Really, that's a big collaboration that NIJ sponsors, but we in general will collaborate with anyone in the field from around the world, and basically if they say there's a problem, I'll talk to a graduate student about working on that problem and then we find a way to work towards a solution.

**Gabby DiEmma** [00:15:09] So for those who may not be familiar with novel psychoactive substances or NPS and NPS Discovery, can you tell us more about what the NPS Discovery initiative is about?

**Karen Scott** [00:15:20] So they are evaluating samples that come primarily, my understanding, that come primarily through NMS Labs. They are screening those samples using QTOF and evaluating what is showing up nationwide in blood and urine samples to see the fullness of novel psychoactive substances throughout the country and then building their database to educate the country and I guess the world in terms of trends of NPS usage on a month-by-month basis. They have a tool that has been developed to show these different trends for the benzodiazepines, opioids, cannabinoids and stimulant drugs. They produce quarterly reports to evaluate which drugs are more frequently being seen in the casework, which are the, you know, what are the hot drugs or which ones are becoming less popularly used on a month-by-month basis and then there's an annual report each year that comes out also.

**Jarrad Wagner** [00:16:27] Yeah so it's interesting you mentioned NPS discoveries. So that's a really great group that's being run out of the CFSRE. Dr. Alex Krotulski is working on that. And you may remember when we met I was actually visiting NMS Labs and the CFSRE up in the Philadelphia area and talking about some of the research that we do. So being able to interact with Arcadia students or students, different school, that's completely reasonable. But I was able to get to know a little bit of the work they're doing there. They're doing very important work in identifying novel psychoactive substances, novel or new, and there's a lot of very unique compounds coming up. And because of my work in clandestine laboratories and wanting to stay on top of the different precursors and the different compounds that are out there to understand what's affecting people, it's been important for me to follow the NPS Discovery work, and I'm trying to encourage them to get involved in, it's a group called CLIC, but it's Clandestine Laboratory Investigating Chemists, and basically where we investigate clandestine laboratories and we're chemists and it's important for us to know what is out there in the world. And that's something that NPS Discovery is very good at doing, is characterizing these compounds, identifying them so that we know what we're actually looking for.

**Gabby DiEmma** [00:17:45] So we've already discussed some of the opportunities for student research, but what are some of the opportunities for hands on learning in addition to that research, as well as some of those internships you may have already alluded to?

**Jarrad Wagner** [00:17:58] Internships are important and working on real world problems and so our campus has the medical examiner. We just built a brand-new building for them, so the office of chief medical examiner for the state of Oklahoma is actually on our campus. And the city of Tulsa Police Crime Laboratory is in the same building. So the property room is on the first floor, the crime lab is on the second floor, and then we're located on the third floor of the Forensic Sciences Building. So we have a really unique opportunity in Oklahoma to do local collaborations with those agencies. In addition to placing students at those different laboratories, we have the Federal Aviation Administration lab that's local in Oklahoma City. You know, so I'm focusing on local, but really I have students everywhere because we're able to do the online component and so you can do that online component. So I think internships are a really important part of graduate school and I did two internships. I did a local internship with the Orange County sheriffs, where I ended up working. I also did the FBI Honors Internship Program, and my first mentor was Mark LeBeau, actually. So if you look overall at the entire field, internships are really important and I facilitate those because I know a lot of people in the field and we work together. Really try and just create an environment where students get an opportunity for hands on no matter where it is. So we have some agreements that different organizations can sign when they host a student. Sometimes it's a graded experience where it's actually a course, an internship course, and other times it's just a research experience or something a little bit more informal, and it depends on the situation. But absolutely internships are, in my opinion, a critical part of what we do.

**Karen Scott** [00:19:42] So Arcadia has hands on learning right from the first semester. We have a crime scene house where students will learn how evidence is collected and the importance of proper techniques for that collection. They also learned about pattern evidence during that particular class. Also, in the first semester of the program, they have an instrumental analysis class where they learn those techniques of analytical chemistry. So things like GC-MS, LC-MS, solid phase extraction, the kind of primary instrumental analysis techniques that are going to see them through the classes such as forensic chemistry, forensic toxicology and those upper level classes that they do in the second

semester into the second year of the program. So for each of those classes that they take, the chemistry, toxicology, biology, microscopy, each of those classes is supported by the laboratory. So it's a very hands on program. We firmly believe that students learn by doing. So while everything is underpinned by lectures, the students also have that hands on experience. We have laboratories both on campus where we have microscopy suite, as well as an analytical suite for the chemistry and toxicology labs, plus the DNA, and as I mentioned, we also have the partnership with the Center for Forensic Science Research and Education, where they have a large suite of analytical instrumentation both for chemistry, toxicology and DNA.

**Gabby DiEmma** [00:21:24] So what do you and your collaborators do to stay on top of the constantly evolving landscape of emerging drugs and novel psychoactive substances in toxicology?

**Jarrad Wagner** [00:21:35] Well, for me, I really have faculty that are supporting our institution, and they're qualified as graduate faculty, but they're running crime labs around the country. They have a Ph.D. They might have internship opportunities for students so they can host a student and be advisors. But they're actually in the field, right? They're running these labs and they know the problems they're facing. So it's not a challenge for me to try and stay on top of it, because students I'm working with and the people that I'm working with as collaborators are in the real world, and they're seeing drivers with these novel benzos, in some cases being pulled over for a DUI where it's just a human performance issues, and in other cases they're dead. Because we're actually doing real world things and doing research that solves real world problems, it's not hard for me to stay on top of it and also, you know, I'm fairly known for the collaboration. So when there's a really unique problem, I'll have people reach out and say, Hey, do you know anything about this? And so I might put them in touch with Alex Krotulski or someone at NPS Discovery or, you know, someone at a different lab that I'm like, that is a unique problem, but that's one that they've already solved so I'm going to have you talk so-and-so. So that's kind of how we stay on top of it. I think stay on top of it, that's interesting, right? That's implying that we're always successful. And I think for us, it's being aware of the new challenges that we're facing and finding ways to solve the problems. It's not always going to be a completely elegant solution, but part of the problem is that people are using a lot of really dangerous compounds right now. So we're aware of the issues. We can't always solve them, but we're always working towards solutions.

**Karen Scott** [00:23:15] So over the years, we've had several research projects on this particular area. When I first moved here from the UK, I actually brought one of my PhD students with me, her name's Lorna Nisbet and her Ph.D. research was actually on novel psychoactive substances. One of her areas that she looked at was stability of cathinones. So we had a couple of students that worked alongside her on that stability research project, and we actually eventually published that research. Then, alongside our collaborators at the Center for Forensic Science Research and Education, we've done some research looking at human liver microsome work, evaluating some metabolic profiles, and one research project looking at some NBOMes. We also have some research that's planned for next year, looking at some other NPS drugs in a similar manner, looking at metabolic profiles. And we're also planning to do some additional stability work next year also again with some NPS work. So looking at stability work and looking at some metabolic profiles for some of these NPS work to try and expand our knowledge in these areas.

**Gabby DiEmma** [00:24:30] So the interpretation of toxicological analyzes requires an understanding of not only the metabolic pathway of the substances, but also their toxicity levels, tolerance in an individual drug-drug interactions and much more. So how do you go about teaching this complex process to your students?

**Karen Scott** [00:24:50] So we have a couple of classes the first year of the program. We have a pharmacology class. So we start with the basic concept within that class and we build up on that throughout the semester. Hopefully we cover everything throughout that initial class and then the second year of the program, we build on that into our forensic toxicology class. We also encourage our students to attend webinars and symposiums and things like that. So at the moment, I'm chairing the 5th Annual Online Forensic Toxicology Symposium. So we would encourage our students to attend things like that where they can hear from world class experts. We take our students to the American Academy of Forensic Sciences. Sometimes our students have the opportunity to attend other meetings, such as the Society of Forensic Toxicologist meeting also. So we're always encouraging them to expand their knowledge. If there's webinars or seminars and things like that, that would be appropriate in that particular area then we would obviously encourage them to go to that and to carry on expanding their learning. It's not just about what we can teach them, it's about what other experts can also teach them.

**Jarrad Wagner** [00:26:02] That's a tough subject to teach. I think the first thing we have to do, I try and start at the cellular level and really explain what is a receptor, you know? Oh, it's a protein. What is the - is it an enzyme? Is it a receptor? What is it? And so we talk about ion gated channels. We talk about neurology and how nerves function. We talk about so the organism basically on a cellular level and then macroscopically as a whole organism. So you try to explain what's happening with the chemical in the body. Yep. That's what we do. Well, that doesn't sound very difficult, but it can be difficult because you're trying to say there's a mechanism behind the effect this thing is having. And then when you go further and you look at human performance, one of the things that I focus on is supporting the drug recognition expert program and drug recognition experts or police officers that are specifically trained to identify impairment and influence of different drugs. I teach physiology for them. I teach them about pharmacology and support a lot of training events where we have people that are using drugs and they're evaluated by the drug recognition expert. And so that's something that my students are able to help with as well, so that they get some, you know, hands on with different individuals and how their behavior changes with drugs. So it's not just a lecture, it's the actual experience that they have of seeing someone under the influence.

**Gabby DiEmma** [00:27:24] So your students are attending these conferences to learn from other experts, but based on the amount of research and the hands-on work that you do, do they also present their research at these conferences and have any of your students published their results?

**Jarrad Wagner** [00:27:39] Yeah, I think publication of results and presenting them are really important for the work because we have to let people know what we've done and it might help them solve a problem. And so we've gotten quite a few publications. More recently, the university actually has started a journal locally. I haven't published in it yet, but it was designed around creating a publication environment for our medical students because we teach - our program is co-located with the medical school and so we want the students to be able to publish the work. So my students will present at conferences. I actually wasn't able to attend. I had a - there was a conference, the Southwestern Association of Toxicologists, where I wasn't able to attend this year, but I had two students

present work that they did in affiliation with the program. But we also have a way to sponsor students to attend meetings like the American Academy and the Society of Forensic Toxicologist, different types of meetings. We wanted to give people the opportunity to get the work out there, and it's not always easy.

**Karen Scott** [00:28:38] So all of our students have the opportunity to attend the American Academy of Forensic Sciences and whether they present their research at that conference or not depends on how far though they have gotten with their research at the time that the abstracts is due for the academy, which is kind of in the midpoint of the summer session. So I would say that usually about 50% of them get the opportunity to present at the Academy meeting. One of the nice things about the Academy is that there's also the young forensic sciences opportunity for them. So if they're not ready for presentation by the time that the main abstracts are due, then they also have the opportunity to submit for the Young Forensic Sciences Forum in terms of a poster presentation. In terms of publication, we have had success with students publishing in the past. The research I mentioned earlier on NBOMes, that was published. I also mentioned the research on the cathinones stability that was also published. And then myself and one of my other students wrote a publication on the opioids pandemic a couple of years ago, and that was just a review paper on that. It wasn't actually a research paper, it was actually a review paper that we wrote. So we have a mixture of research and other types of papers that we've written together.

**Gabby DiEmma** [00:30:05] Post-graduation, what have your students been up to? How many found work in forensic science at publicly funded labs, at private labs, or, you know, are they continuing research or are they going on to future studies?

**Jarrad Wagner** [00:30:19] So we're in a unique position because we do have the doctoral program so we can have a student if they do very well in their master's thesis and they like to write, they can go on to do research. So I've had students that do that, but all of my students are either in a clinical tox lab or a publicly funded crime lab as alumni. And it really - you asked me about - do they go to meetings? Yeah, you know, they'll go to meetings. They'll interact on projects or internships and it's building those relationships at those meetings when they meet someone and are like, Oh, that might be interesting to work there tell me more about it and it just creates opportunities. I recently had an applicant for the program there, they said, Well, do you guys have a career service there? And I said, Well, I guess that's me because all my students have jobs that I help them find the right fit. You know, we focus on publicly funded crime labs, but honestly, there are lots of different types of laboratories out there in industry. So, you know, we have clinical we have quality assurance in different industries. So I really focus on giving the students the techniques and the skills that they need and then help them find the right position for them.

**Karen Scott** [00:31:25] So for the Arcadia cohort, we have had really good luck with recruiting our students and we get a lot of emails from industry reaching out saying, you know, we have these jobs, can you please send this out to your current students and alumni? You know, we have a job, an offer because they know that the students that come from these FEPAC accredited programs are of a high quality. It's really great for us to have that. In terms of recruitment of our students, our graduation ceremonies are this week, and already 50% of the students in the current graduating class have employment, which is really awesome. So we have a student who's going to NMS labs and we have two students who've already started working at the Armed Forces Lab down in Dover, Delaware. The other 50% of the class are still actively seeking employment. We know roughly where about 80% over alumni currently are and I would say around 90% of those

are gainfully employed in either forensic science or related fields, and a large proportion of those students are either public or private labs. So this is like NMS Labs. NMS Labs is a large employer for us, just due to the locality. A lot of our students come from local areas and want to stay in local areas. We have a lot of students that work the offices of chief medical examiners. Some of our students go and work at the Center for Forensic Science Research and Education. We do have a number of students who go on to Ph.D. programs, so they go on to further their education. We have students that go to medical school, law school, even veterinary school. The vast majority of them do end up in employment and within forensic science, I would say.

**Gabby DiEmma** [00:33:20] Very cool and that's a perfect note to end on. So I would like to thank Dr. Scott and Dr. Wagner for joining us on the podcast and for taking the time out of your day to chat with me.

**Jarrad Wagner** [00:33:30] Thank you, Gabby.

**Karen Scott** [00:33:31] And thank you very much.

**Gabby DiEmma** [00:33:33] And if you enjoyed today's podcast, be sure to like and follow Just Science on your platform of choice. For more information on today's topic and resources in the forensics field, visit [ForensicCOE.org](http://ForensicCOE.org). I'm Gabby DiEmma and this has been another episode of Just Science.

**Voiceover** [00:33:52] Next week, Just Science sits down with Dr. Peter Stout, Dr. Ray Wickenheiser and Matthew Gamette to discuss recommendations for students and faculty in FEPAC accredited programs. Opinions or points of views expressed in this podcast represent a consensus of the authors and do not necessarily represent the official position or policies of its funding.