SIPR Events – Podcasts

STAN BROWN – Chief Executive of Forensic Science Northern Ireland (FSNI)

- Good afternoon and thank you for the invitation to speak here today.
- I'm speaking primarily for myself here, but Sheila Willis – who is the director of the Irish Forensic Science Laboratory and Chair of the Association of Forensic Science Providers (AFSP) has sent all the good slides, mine are the bad ones. If there are any hard questions I will post to her, the easy ones I will take directly.
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- I am not speaking on behalf of AFSP but I what I'm going to be say will probably reflect their opinion pretty solidly, and as there are some other members of AFSP here, they can chip in and tell me I'm wrong, if indeed I am wrong.
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- The AFSP constitutes about 95% of forensic science provision (outside of the police forces themselves) in the UK and Ireland. Firstly, just a little bit about our own agency FSNI – it's a government executive agency, therefore I'm a civil servant. Sometimes perhaps I am not very civil but I am a servant.
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- FSNI have an international reputation based around the troubles; we have 30 years of terrorism campaigns and therefore we are well versed in explosives and firearms and many other areas as well. There are around 215 staff at FSNI and about 2/3 are scientists.
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- We have a broader range of forensic technical specialisms than most other single labs – probably one of the broader ranges of accreditation in Europe for any one single site. And that range is an important aspect – the integration of various different forensic approaches is very important, especially in serious cases.
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- Looking now at the NAS report; It is highly critical of the lack of scientific validation, of the development of science in law enforcement agencies, of reliance on critical specialist groups as a source of standardisation. However I think, personally, that it is naive in expecting that all forensic science should be probabilistically quantifiable. It is idealistic to think that science is essentially about measurement (and ideally it is) but forensic science is too "messy" an area, with too many unknowns, too many uncontrolled variables, too many non-bespoke aspects for it to be always probabilistically quantifiable.
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- DNA is one prime example, and we had a little mini conversation about that earlier. While we can put a firm number on a DNA profile match, that is a very different thing from putting the same confidence on assessing why DNA is present and how it actually got there. I know for example, the Body Fluids Forum (a lovely named group) of the AFSP is working on the (indirect) transfer of (female) DNA through social contact onto the genitals of males, which makes its appear that they may have had (direct) sexual contact. How the DNA can get there is hugely important to the interpretation of what actually happened. So having a match probability number, say 1 in a billion, gives a false impression that you've got an exactitude - which actually doesn't exist, because far too many of the other variables are unknown and are unquantifiable. The court needs to understand that. And we have found that quite often the police will see DNA as the magic bullet, for the same reason of too much faith in a match probability. They have too high expectations about it, because perhaps of the emphasis put on one part of the end-to-end process, which is the analysis of the samples and the production of profiles. It is actually the fastest and cheapest part of the whole process (in terms of unit costs).
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- So, how do we compare in the UK generally speaking versus the US? It's very interesting to hear Barry's conversation there. All the main UK providers are independent from the police – in contrast to the US. There are some police labs that do some of the primary evidence recovery, but all the main providers are independent. All are accredited to ISO17025:2005 and all are inspected by UKAS - which has the government's authority to do that - at least annually. And those inspections are very rigorous. We at FSNI have just been inspected by UKAS last week, and we had up to 8 inspectors present for 5 days, observing procedures, checking our documentation and so on.
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- Accreditation isn't about setting a standard procedure for doing everything and then sticking to it. It's about developing those procedures, making them better and better as time goes on. Effective quality management systems are about continuous improvement. Therefore I am always dubious when I hear people talking about setting the best practice standard protocol and then everyone just follows that protocol. That would freeze forensic science and be counterproductive.
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- All the providers have quality management systems; we work in collaborative groups – both in the UK and Ireland – under ASFP - and in Europe, under ENFSI. We all quality manage our systems to ensure that staff competencies can be maintained. And they can be expensive to maintain and time consuming. If we recruit a PhD biologist, it takes at least 2 or possibly 3 years to make them into a Court Reporting Officer (RO). Only then are they allowed to give evidence in court. So it's normally a process of "forensicating" a scientist, as opposed to hiring a forensic scientist, and we always, when recruiting RO's prefer the route of taking a specialist, in chemistry or whatever, and then making them into a forensic scientist. Rather than taking the route of pre-made forensic scientists which is a more generalist base usually initially employed at the more junior grades.
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- All providers' work is peer reviewed under their QMS and on top of that there is usually dip-sampling by senior management of a certain amount of work. We have the Regulator in place, who is strongly supported by the providers. In many industries which are regulated, they are in some respects reluctant "regulatees". In this particular industry the providers want effective regulation and to work extremely closely with the regulator.
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- The US and UK both have adversarial systems, whereas Europe has an inquisitorial system which makes a difference, as in UK it is mor common for Reporting Officers to appear in court and be cross examined. In Northern Ireland, because of the history of the troubles, the defence can be particularly aggressive in court. Possibly the most aggressive cross-examination of forensic expert witnesses in the UK occurs in Northern Ireland.
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- We'll move on now to 'giving rigour' to the unquantifiable. As I said earlier, not everything is quantifiable. And when is an expert opinion "subjective"? People talked earlier about belief and the NAS report refers to it. A scientist doesn't use the word "belief" like a minister of the church uses it.
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- Expert opinion should be robust, objective, logical and transparent. Those four words have been adopted by the AFSP as the "four pillars" of forensic science expert opinion. If you give an opinion in court, how robust is it to cross examination, how objective can you demonstrate that you are, how logical is the process from which you are deriving your opinions and how transparent is it. So people can actually see at every stage where there might be errors or even where they can challenge you. This is not easy and a great deal of collaboration is underway between the providers on this issue.

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- Because there are so many variables in people, scenes, and exhibits, there are many uncontrolled variables potentially affecting the evidence which is to be recovered. You can attempt to add rigour to analyses such as fibre populations through persistence studies for example but it is specific circumstances - local effects - which irreducibly prevent you being precise. When we talk about fibre transfer from one person's clothing to another persons clothing, you can do all sorts of tests on many cases but you still don't know how variable the local effects are in the one case in question. Did the local shops sell 3,000 of those jumpers last week? So you can't meaningfully take an average UK population of various fibres and then extrapolate it to the local, to the actual scene. Did the whole family buy the same kit together or are they all supporters of the same football team? – too many variables to quantify.
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- Also the rate at which fibres fall off could depend on all sorts of things – the weather, the movement, what else they are wearing, static electricity from the carpet. So we might not be able to actually assign a meaningful overall probability on the results in any one case. We would instead need to validate the process of expert evaluation and find out how we can have confidence in the judgement of the experts themselves. Confidence is however never absolute.
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- It was mentioned earlier about the term "laboratory" – everyone tends to call forensic laboratories 'labs' as if what they were was captured in that one syllable. Well, I've worked for large American and UK multinational corporations and for Ordnance Survey which is a technical-based agency involved in many aspects of public life. However, FSNI is the most complex organisation I've ever worked in - even though it is only 215 people! The complexity lies in what has to be controlled; legally, logistically, administratively, technically and scientifically. And this complexity impacts on all providers every day in terms of managing our resources. So it is very misleading to refer to a "lab" and then imagine it is just 'boffins in white coats doing tests'. As if the test was the main thing. The test itself is often the more straightforward part.
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- Many of the critical processes involved are not essentially laboratory tests at all and they are also, at core, not standardisable commodity functions. The more complex the case, the more bespoke the treatment. The nearest analogue to a forensic lab, I would argue, is not a hospital lab but the hospital itself, where you have your specialist consultants – orthopaedic surgeons, neurologists, gynaecologists, brain surgeons and so on – working with the hospitals own labs, radiography and operating theatres and with the patients referred to them by GPs. The police are - in this analogy - the equivalent of the GP, but referring exhibits rather than patients to the consultants. If the forensic provider is not seen in the full context then you are potentially loosing a lot of value.
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- The forensic process (as seen from the beginning to the end, and from both police and forensic providers' perspectives) starts with scene handling and recovery of exhibits - there are all sorts of things in here where quality can go wrong. How do you handle and protect the scene? What's your forensic strategy? What exhibits should you take and what should you not take? What should you submit and when, what you should not submit? You will be aware of the terrorist attack in March of this year, when Dissident Republicans killed two soldiers in County Antrim. FSNI had initially 4 or 5 forensic strategy meetings a day with police, involving many people, with substantial numbers of scientists then working 7 days a week, 12 to 14 hours a day to investigate that one case. There have been around 1,000 exhibits taken and many more yet to be submitted. Some of those exhibits have undergone multiple tests. The lead scientists would have been asking questions in such cases such as "Do I take DNA or fingerprints first or should I take fibres first? If I swab for DNA am I destroying ridge detail on latent fingerprints? Do I

control the whole thing for Low Copy Number DNA? How do I do this? What is the impact on speed? These are big decisions being taken between the forensic scientists and the police. Something compromised here can affect the entire case all the way down.

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- Then you have the exhibit packaging, which is extremely important, the labelling (which came up as an issue 10 years later in the case of the Omagh bomb), the storage and then the tracking. We must not lose one single exhibit. FSNI receive about 20,000 exhibits a year, plus a similar number of DNA samples. From those 20,000 primary exhibits we derive about 80,000 sub-exhibits. Every one of them must have all its movements tracked. We need to know where it is, where it's been. We must maintain separation of exhibits from the suspect from those from the injured party at all times. We must decontaminate the rooms as the exhibits are moved between these different places. A lot of logistics, and potential failure points. There are also the files that have to be created and then later disclosed and again we mustn't loose one of those.
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- Once you've got the exhibit in place for examination – you can use different methods for recovering the evidence, involving swabbing, taping, shaking out, vacuuming, extracting, reacting, exciting (which sounds more exciting that it actually is) and visualising. And then you have the analysis part, which most laypeople think forensic science actually is. It's the instrumental tests for drugs or the manual tests for blood and so on. The instruments are more or less standard instruments that you'd find in any other type of laboratory – gas chromatographs, liquid chromatographs, mass spectrometers (sometimes in combination); various types of spectroscopes – infrared, visible, ultraviolet, and so on; comparative stereo microscopy, scanning electron microscopy, DNA extraction, quantification, amplification, capillary electrophoresis and profiling. Those are the lab-based, bench-top type instruments that providers use and it is important for R&D planning to remember that most of those instruments are standard instruments that you can find, for example, in water treatment or pharmaceutical laboratories.
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- You have also to give investigative advice to the police, sometimes in very quick time, in some cases within hours or days. There might be a bail hearing, someone possibly presenting a danger to society might be about to be released for lack of forensic evidence to justify remanding him in custody. So this sort of thing can be very important.
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- You then have to go to the evaluation part, which is assessing the findings in context; looking at alternative hypotheses and coming to an opinion about the strength of support for these. This is delivered through the written report and expert witness in court. I've previously mentioned these four principles: robust, logical, transparent and objective, within the competencies of the expert. Forensic scientists have very discreet competencies. I cannot take a biologist and say, "would you like to do some scanning electron microscopy today while the SEM specialist is off sick?" You cannot do that. The competencies are very clearly defined and it may take years of training to move a person from one to the other. So we have, at FSNI, as in other providers, roughly a dozen or so different streams of science and we cannot easily move people between them. Therefore we cannot readily and rapidly load balance. We have an inherently very rigid response to demand fluctuations, which is a very important issue in any business operation.
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- The work on exhibits is often not repeatable; sometimes you can do it once only. Quality is therefore the absolute king. You'll be pilloried in court if there is anything wrong with your quality. And the administrative logistics must also be extremely robust – it's not just the quality of the science. The sequencing which I mentioned before in regard to coordinating joint examinations is also very important. Deciding what procedures to carry out and in which order is of major importance and is coordinated through lead forensic scientists who have a general

view of how the different forensic science streams integrate with each other and who advise the senior investigating officer of the case. In simple cases, it's often less integrated but in major cases it's extremely integrated.

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- So that, in a nutshell, is the overall process. We have the crime occurring, the police determining it is a crime, they appoint an investigating officer, there are activities at the scene of the crime. If it's a major case an expert lead scientist might be called out and be present at the scene as well. Items are then prepared for submission and they are screened through the scientific support management unit of the police and onto submission control. There are financial decisions made there by the police – how much can they afford to do at this stage. There is a screening process, a decision process. Exhibits come in to the provider who checks the quality and note and records any quality failures or anything out of place on any of these items. Is the tamper evident packaging intact? Is it in the right type of packaging? Is it properly labelled? And then we have to store it in deep freeze, refrigeration or at ambient temperatures as appropriate.
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- The exhibit then usually goes firstly to the primary evidence recovery unit or to analytics, DNA or the various specialisms such as explosives, firearms or whatever. The reporting officers, who are at the nexus of this all, are calling out the work from the lab and they're liaising with SIO's to determine what work is to be done. So there are decisions being made all time. We then give the SIO an interim report, which might support the investigation and then we ultimately deliver an evaluative report to the police and public prosecutor and eventually give expert evidence in court. So it's quite a complicated end-to-end process. Things could go wrong at any part of it and research could therefore be usefully applied to any part of it. All parts of this process flow could be improved – either validated or physically improved by research and development.
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- Also forensic scientists operate in two philosophically different modes. The investigative mode – in which they ask 'what is the likelihood of the proposition given the evidence'? I found this footwear mark, looks like it's a Puma, size 9 (or whatever). The polciue are informed, when arresting your suspect, look for that type of footwear, take them as exhibits. The scientist is not presuming the person is guilty, he is advising the police as to what they should be looking for – investigative advice. In court however, it is the exact reverse; it is 'what is the likelihood of the evidence given the prosecution's proposition versus its likelihood given the defence's'. So it's not sufficient to say an exhibit is similar, or indeed that a result is consistent with the prosecution's proposition. It is necessary to say 'the probability of finding this evidence is high given the prosecution's proposition but low given the defence's (or indeed the reverse) and to explain how this opinion is derived. If you don't get that right you might end up with the prosecutor's fallacy – where you can jump from one statistical meaning to another, totally different and inappropriate one. DNA profile match probability is one example of that, where the probability of a match and the probability of guilt are very different things. All forensic scientists will be trained and alert to this; it should be in their blood. They must operate in these modes.
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- In forensic science, we're (and I exaggerate to make the point) talking about the "clash of two civilisations" – the laws of science versus the laws of man. Scientifically, laws are discovered, not invented, not legislated, not set by precedent in courts. The "scientific method" is sacrosanct, it applies to all sciences – whether it be biology or chemistry or whatever. You can't have a different "scientific method" in Italy than you have in Brazil[1]. Scientists should not be

[1] To clarify a point made subsequently in the discussion session. I am not saying that experimental or testing procedures used in forensic science in different places cannot differ – best practice develops over time and is never uniformly applied. My point is that the rigours of scientific peer review and challenge know no geographical

dogmatic and, in my opinion, should never say “I am certain that…”, because uncertainty is built into science. Scientists should challenge each other through peer review. We have also (as in all areas of science) much international collaboration, which isn’t perfect but there is a lot of it actually taking place.

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- The precepts of science are however not always fully understood by the legal profession. A senior judge once expressed to me his bewilderment that scientists could disagree. He said, “What I can’t get my head around is that scientists, different experts, are disagreeing. Science is all about facts, after all, how can they disagree?’ He is of course quite wrong and clearly didn’t understand science at all. At FSNI we give lectures on forensic science to trainee barristers in their final year and the first question we ask is ‘How many of you think science gives certainty?’ Their hands shoot up to the ceiling instantaneously. We explain then, to their initial disappointment, that science can do very high probability but it doesn’t do certainty.

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- Science (and particularly forensic science with its intrinsically less controlable variables) is more about probabilities than certainties. Some of the methods are very standardised and if you’ve got the samples correctly and don’t mix them up, you’re pretty confident. So with blood alcohol level for a “drunk in charge”, you’ve got a very high confidence level that that the person did actually take alcohol and it’s in their blood to that level. Not 100% certainty perhaps, but approaching it. Other methods are much more interpretative than that, they depend very much on context and judgement. Firearms Discharge Residues for example. You remember the murder of Jill Dando, and Barry George whose conviction depended in part on one particle found months later inside his pocket. That one particle could have been shed off the clothing of the armed arresting officer and that particle statistically has no meaning. Yet it was used to help convict him. This is an example of the scientist finding a particle, saying I am confident, because of the technical analysis, that it is a particle of firearm discharge residue. But that’s not the same thing as saying he was guilty because of that single particle or that he fired the murder weapon.

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- We also see, and I think the NAS report alluded to this, that the “CSI Effect” is also very prevalent in the UK. People often presume from watching these programmes that they understand what forensic science is. Most of the legal profession - and this is an observation, not an insult coming from a scientist - are Arts & Humanities graduates. They didn’t do science beyond secondary education in many cases; therefore they don’t quite get what science fundamentally is. I’m often finding this when I speak to them, there’s this dichotomy in the alliance of science and the law, which needs to be explained. The other thing is that we’re not looking for certainty in any one test evaluation. Multiple findings from diverse examinations may yield a higher overall probability through a Bayesian approach. The joint probabilities may help build a very strong case. Even evaluations which individually provide weak support may collectively strengthen the case.

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- So we have these two worlds; where science is about testing theories, never proving them. Provisionally and certainty are at its core, the meaning of words is highly specific to a scientist and may have a very different meaning to non-scientistsg. Scientists, generally speaking, are not very competent at expressing themselves or explaining the complexity of their subject. They’re often introverts. Whereas with the Law, the emphasis is on legal precedent, and sometimes demands of the scientist for a black and white contribution – ‘Is it possible that?’ Well, the answer to that question for a scientist is almost always ‘Yes’, because nearly anything is possible but whether it is probable is a different matter. And the legal arguments are made by

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boundaries. Assumptions, error rates, controls, etc. etc. the basic elements of the scientific method – are not subject to the law of any country.

people whose main skill is language manipulation. We have two different worlds, the world of the barrister versus the world of the scientist. Different personalities, different meanings. What does the word “contamination” mean to each of these audiences?’ If, as a non-scientist, you thought the evidence was contaminated, you’d think ‘I cant’ trust it, that’s it – gone.’ When you think about it, though, all forensic evidence is in reality contamination. If I leave my DNA on the table, the table is “contaminated” with my DNA. If I shed fibres, the fibres are contaminating the surface. So we need to understand what the word contamination means.

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- In the Omagh bomb trial, which some of you will have followed, the court did not appear, in the opinion of most forensic scientists, to fully understand the contamination issues or at least address them adequately in the judgement summary.

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- So forensic science is a process, but there is a lack of clarity of the roles of the players within it. When should an SIO defer to the forensic scientist? How much say does the forensic scientist have in the early part of the investigation in terms of what actually should happen? If the provider is not given enough exhibits from a case, what can they do about it? I’ve heard anecdotally in England, where police have high cost pressures, that sometimes police pre-screening units are cutting squares out of suspect’s or IP’s clothing, and sending the square in for the lab to simply confirm if it’s blood and, if so, whose. What this means is the elimination of opportunities for blood pattern analysis of the garment and therefore “dumbing down” of forensic science in order to save money. What does the provider do about that, in a competitive market? Do they just accept it or do they caveat their reports with ‘my evaluation is based on limited input which has been compromised because …’. These are important questions.

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- Different jurisdictions manage the end-to-end process differently. In Scotland, the SOCO’s fall under Tom Nelson’s team, they are part of the forensic provision. In the rest of the UK they’re not, they fall under the police. And nobody’s quite sure which is the best arrangement. So, where do we need the research? Well it’s a multistage stage process and we need research, as I said on that flow diagram, on virtually all parts of it. Effectiveness (or quality) and efficiency are both important to providers. I’ll explain why efficiency is important, where the intervention is needed and when.

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- Blue skies research is relatively rare in forensic science because forensic science is an applied science; as someone said earlier ‘it’s not pure science’. It is the application of pretty well established science. I apologise for the use of the word ‘paradigm’ in this slide, which we were told earlier we were not allowed to use, but that’s Sheila’s slide!

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- R&D already takes place in instrumental and other material manufacture right across the market. So someone who is manufacturing gas-chromatographs (GC’s) isn’t doing it primarily for forensic science. The forensic science market probably constitutes less than 1% of the world market for GCs. So research in improving those machines is really done for other markets. And forensic science might well manipulate and exploit those developments. And the same thing applies to spectroscopes, microscopes, to electrophoresis, even with DNA for example with reagents and kits, although some of them are forensic specific.

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- The application development is driven by real issues determined by real cases. For example, some years ago, our people were using scanning electron microscopes to look for cartridge discharge residue on the little stubs used to vacuum recover particles. This involved a manual search, people spending days looking for individual particles, then photographing them and taking x-ray spectra. Our people, working with the manufacturers, designed an algorithm to automatically search the entire stub overnight. Our people went home, came in the next day and

the machine had automatically found, and spectrally analysed all the different particles, saving weeks of work. There is an example where application development directly affects the output capacity of a forensic lab.

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- Science used in court does need to be robust and ideally forensically validated, which is distinct from scientifically validated because they're two different things. Just because a test works scientifically does not necessarily imply it has forensic meaning. The forensic validation will therefore lag some considerable time behind the availability of the new technology itself in other markets. It would be wrong to prevent access to the court to new science or technology, because then the science would be held back by the legal aspects and lag well behind its use elsewhere. But the courts are not well served if novel technologies are shown later to be unreliable and have given rise to a possible miscarriage of justice, or indeed the converse as in the Omagh trial. In that trial, the judge queried Low Copy Number DNA after an American expert witness essentially told the court that 'We don't use it in America'. The judge apparently construed that if the use of the science wasn't established in America it cannot be relied upon in UK. The court also didn't know if LCN DNA had been independently validated, when in fact it had been by UKAS. And therefore the court thought LCN DNA was less valid as a test than it actually was. The real query of Low Copy Number is not so much about the process methodology, it's about the interpretation of what you find with such a sensitive method and that interpretation aspect was not as fully explored in the Omagh case as it might have been. So both of those things are wrong: to actually hold a science back too much or too little.

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- We do have to think about validating the methods that we have. The scientific approach does need to be improved in some of them. There is too much emphasis on precedent, as people have said before; and lack of clarity of the roles of the various actors in the process. Ad hoc groups do meet, as we've mentioned for example in the Body Fluids Forum. There are all sorts of forums operating across ENFSI and AFSP working on particular specialisms. But it needs an external validation, I think, to put a stamp on top of that[2]. And the system is open to criticism if best practice is not adopted universally, which may, as we have seen be a wrong assumption to make.

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- We also have to think of interoperability – a method we use in one country should be transferable to another one so we can share data, interchangeably to help with cross–border crime for example. Database structures need to be such that the information can be shared to common standards, as do quality standards.

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- We need to validate methods and publish them, to gather data to assist in interpretation, but also to be aware that not everything is quantifiable. As I've said before, some things are beyond precise quantification, they are in the more heuristic areas where the expert is using his years of experience to come to an objective as possible judgement as to what the evidence is actually saying. In that case we should test the expert through objective proficiency testing. At least you're testing the skills and processes of evaluation that the expert uses if not the actual objective case statistics.

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- We need to ask ourselves what is the effect of the marketisation of forensic science. The UK is the only country in Europe where there is such a market. I mentioned earlier the example of submitting cut out samples of clothing to save costs. There are also other pressures that bear on providers in a competitive market. How do people share intellectual property if they're competing commercially? How will that be actually managed? With regard to Quality Assurance,

[2] Perhaps by having academics represented on the joint working groups.

at the moment providers all collaborate in quality – they do blind trials for each other. What though could one provider do to a commercial competitor if they knew that they failed a quality trial. How would that help the overall quality process? There are lots of things which need to be worked out on that issue and the regulator has a key role to play.

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- With regard to efficiency, only a fraction of all criminal cases are forensically examined. A sizeable portion of volume crime goes nowhere near forensics because there is not enough capacity to deal with it, but there is huge potential. One reason is insufficient resources; either in police budgets or in providers. Many processes and joint examinations must be carefully chosen and sequenced and that can mean that you can't chose to do some work on a particular item that has been compromised in some way. We can't move specialists between different specialisms. The result of these intrinsic inflexibilities is backlogs in virtually every provider in the UK and Europe. From reading the NAS report, quite a lot of labs in America also have backlogs. So there is real potential for more work to be done by forensic science which is currently not doable because the providers themselves are in some respects intrinsically inefficient; because their processes haven't been honed, haven't been optimised sufficiently.
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- There is latent evidence out there which we can't process. But how could we invest in that if we don't know what the benefits will be? There is no clear documented linkage between forensic inputs and policing and justice outcomes. Everyone knows that retrials, appeals and other delays cost a lot of money, but nobody is linking these and quantifying how we should therefore invest more in forensic science to get the returns we want.
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- For my money, I think R&D could focus on some of the resource-hungry forensic processes – non destructive, in-situ search and detection for example. Looking for blood on garments - small spots of blood - is a very time consuming manual process. Most of the costs of a forensic laboratory are manual labour. It might be intellectual manual labour, but nonetheless manual labour. You can't size up on that and make it ten times more efficient like producing widgets. It boils down to individuals working on the individual items more or less in a bespoke way. DNA processing is a semi-automated or automated technical process but is not the truly forensic part of forensic science.
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- What I'd like to see are rapid methods that are joint-examination-proof. In other words they don't destroy or compromise the evidence but they point you quickly at it. Something that can do this quickly through automatic scanning and detection would be very helpful in cutting down on those labour intensive processes.
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- Parallel processes of interrelated evidence types would also be of interest. As, for example nearly all used paper money will have some drug traces on it, how do you show then that somebody handled that money as part of a drug deal? If you could correlate the fingerprints with the drugs, simultaneously you're linking together more closely the source of the evidence and the presence of the evidence. Which is very useful, to link various types of evidence together like that and to reduce the ambiguities around contamination.
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- In the food industry, for example, you have rapid methods for detecting bacteria on surfaces to see if they were properly decontaminated. Using bioluminescence from the enzyme luciferase derived from the Horseshoe-crab, which emits light in the presence of ATP, you can more or less instantly see where the bacteria or somatic cells are likely to be on the surfaces. And if anything shows up, you can do the traditional, and much more time-consuming traditional bacteriology after that. If we can have something analogous to that in forensic science it would

be extremely useful. I know there are lab-on-a-chip developments which could be helpful in this regard as well.

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- Evaluation and contamination – what happens in primary, secondary and tertiary contamination. How is DNA spread? Is there a difference in the pattern of DNA you get between airborne contamination versus handling? What does it look like? Could we differentiate statistically between primary, secondary and tertiary transfer of DNA.

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- Quality control – contamination control systems and methodologies. Most labs have an ad hoc basis for identifying contaminants, choosing decontaminants, and identifying the processes and equipment to do it. In the food industry, there is a large amount of research done on that very topic. The decontamination and control of contamination in food factories is often way ahead of that in hospitals, for example - you know the debate in the UK about hospital hygiene. Hospital hygiene is perhaps 20 years behind industrial food hygiene and nobody had transferred the technology across the industry barrier[3]. Could we do that with forensic science? Is technology transfer another useful subject for R&D.

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- Forensic science is unusual as there is not a great deal of collaboration with academic institutions, there are exceptions of course – Strathclyde being one and Queens University in Belfast work quite closely with us as well. Most professions' developments originate from academic research, such as in medicine. Forensic providers essentially depend on their suppliers to actually improve their equipment. Providers' production pressures, especially with ever-present backlogs, compete for R&D time. The best application development is however often done by the scientists actually doing the work, but who typically have no time – too much work to do, too many cases coming in, no time to dedicate to R&D. We need some relief from that.

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- As said before, the forensic market for forensic science providers' own suppliers is actually very small compared to other markets for the same suppliers. Therefore we need some dedicated funding for R&D to bring focus on forensic needs. We need to free up the R&D resource, we need to improve collaboration between the academics and the providers. And we need to think about how to best share what is developed because the court system want the same science across the whole of the UK and not held for intellectual property reasons within the control of one provider.

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- Research funding bodies need to be aware of the value and needs of forensic science and seminars such as this are one way of doing this. We need to understand the mechanisms of the interaction between the various players as well as what's actually needed from them and a clarity about those roles. Jim inspected us a few months ago with the Criminal Justice Inspectorate of Northern Ireland and one of their recommendations was that there should be a forensic strategy for Northern Ireland. This recommendation has been accepted by the Northern Ireland office, so we're the first part of the UK to actually have an overarching forensic strategy in the making - where all the major stakeholders will come together and try to decide what is actually needed by forensic science and the Criminal Justice System.

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- A most important thing, as I mentioned earlier, is understanding the link between the forensic inputs and the policing and justice outcomes, and therefore between investments and payback. The NPIA had suggested they should centrally control R&D in forensic science, but the providers believe that that would be a mistake, except in some blue sky Research areas, with

[3] The use of alcoholic hand gels has been standard for 20 years in the food industry, for example.

the involvement of the providers. As I said before, most of the process application Development is best done by scientists working on real issues in real laboratories. And it's through dialogue that we can enhance the payback on R&D.

Thank you.