

The Royal Statistical Society's Statistics and Law Section's submission to the House of Lords Science and Technology inquiry on Forensic Science. The RSS is a learned society and professional body for statisticians and data analysts. We have around 9,000 members worldwide - but the majority of our membership is UK-based.

This response addresses those areas of forensic science that involve statistical reasoning. We consider both, the areas of forensic work where statistical reasoning is applied, and, the areas where it might be applied and is not at present. Statistical reasoning has been used to evaluate matches between evidence such as fingerprints, glass fragments and DNA from crimes scenes and samples from possible suspects. There appears to be insufficient appreciation of the extent to which the main current forms of forensic evidence, including blood drug alcohol measurements, are founded on statistical methods, models and reasoning.

In any application of science, it is necessary to properly evaluate and communicate uncertainty. Statistics therefore has an important contribution to the framing of evidential questions, the collection and analysis of data as well as presentation of scientific findings. Civil litigation is often overlooked; however, statistical information is increasingly relevant to personal injury litigation, most notably occupational disease, toxic environmental exposures, and pharmaceutical product liability.

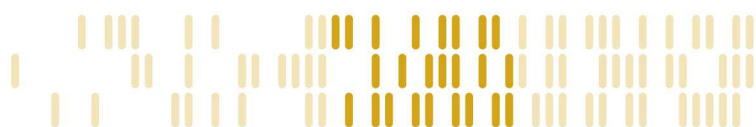
Questions

1. Is forensic science contributing to the delivery of justice in the UK?

Yes - a large number of cases are submitted by police forces for examination by forensic providers in the UK. However, a recent article quoted Home Office statistics that showed an approximately 40 decline in police spending on external forensic science between 2010 and 2015/16 and a further estimated fall of three in the following year.

A better-informed view would be obtained from any data there may be on the number of cases, in offence groupings, submitted by police, prosecution and defence to forensic providers, and by trends in submissions over the years. However, looking simply at numbers of cases does not address the effectiveness of the examinations. This has proven, over many years, notoriously difficult to measure.

2. What are the current strengths and weaknesses of forensic science in support of justice?



Strengths:

- the investigative and probative power of some forms of evidence
- speed of processing of some forms of evidence.

Weaknesses:

- loss of many very experienced staff over the last 10 years.
- inadequate vetting of experts (e.g. Sally Clarke R v Pabon [2018 EWCA Crim 420]); a central register for experts might be useful.
- arbitrary way in which expert witnesses are appointed by legal teams.
- splitting of cases between different providers leads to disparate reports or statements that can fail to bring out the combined power of the forensic evidence.
- commercial pressures leading to "commoditisation" of forensic science and, as a consequence, to potential failure to evaluate the true probative value of the findings in some cases.
- databases tend to be convenience samples, rather than the result of careful design, collection and cleaning: both size of a database and its relevance are important.
- some laboratory standards are based on limited methods for validation and statistical interpretation (for example, there is ongoing statistical work with the FSR on measuring and reporting alcohol and drug blood levels).
- poor quality of probabilistic reasoning and statistical evidence, for example, providing irrelevant information because the correct question is not asked. For example, an expert focused on the rarity of an event, rather than considering two competing explanations of an event.
- with respect to epidemiology in tort law, a concern noted by some practitioner lawyers was the prohibitive costs associated with appointing experts in low or medium value cases, particularly given time pressures.
- lack of time and resources for applied research by forensic science practitioners to improve forensic science effectiveness.
- lack of "blue skies" research by people who understand the requirements of the forensic science process and its position in the criminal justice system.

Understanding and use of Forensic Science in the Criminal Justice System**3a. What is the scientific evidence base for the use of forensic techniques in the investigation and prosecution of crimes?**

The protocol to which the forensic scientist works is very important: the precise questions posed to the scientist or statistician, and the data provided. The details of the protocol heavily influence the answers and should be on the record. This is clearly aided by separating the provider of the analysis from the police or prosecution.

3b. Are there any gaps in that evidence base?

High quality databases are often not available. Databases used for matching are often tend to be convenience samples, even national data bases, (DNA, fingerprints) or proprietary data (glass composition, shoes sold).

Both the size of database and the relevance to the particular question asked must be considered.

There are some areas of forensic science for which validity and reliability studies are limited or non-existent. (e.g. Forensic gait analysis: a primer for courts. Issued: November 2017 DES4929. ISBN: 978-1-78252-302-4)

Large datasets comparable to those provided by the U.S. Department of Commerce's National Institute of Standards and Technology for validation and testing. Computer Forensic Reference Data Sets can be used for training, and to test forensic tools and validate laboratory equipment. <https://www.nist.gov/programs-projects/computer-forensic-reference-data-sets>

There will always be gaps when new methods of analysis are developed, as it takes time to accumulate relevant background or baseline or population databases. Facial recognition data or voice recordings might be limited.

4a. How can the Criminal Justice System be equipped with robust, accurate and transparent forensic science?

The Regulator should be able to set enforceable standards in these respects and be equipped to monitor performance, take sanctions against poor adherence to the standards and deal with complaints. Strong regulation is essential.

An alternative to, or preferably an adjunct to, regulation is a very strong counter-balance through well-resourced, ethical, defence scientists, together with a judiciary that is well-equipped to decide between the sometimes-competing views of experts before the court.

Good quality statistical methods in data collection and analysis; clear and correct probabilistic reasoning. It is essential to evaluate, report and communicate the uncertainty in forensic expert

opinions (as is done for DNA evidence), especially in pattern evidence e.g. fingerprints, bitemarks, firearms, footprints.

4b. What channels of communication are needed between scientists, lawyers and the judiciary?

Scientific reports require clarity about the precise questions addressed, the data, the scientific and statistical methods used.

It might be useful to have guidelines or standards for reports similar to the EQUATOR guidelines for medical publications or those for regulation of medicines.

Meetings with only the scientists and the judge present might be useful. The judge could then test her summaries of evidence for use by directing the jury.

5. What is the level of understanding of forensic science within the Criminal Justice System amongst lawyers, judges and juries? How can it be improved?

There appears to be an under-appreciation of the extent to which the main current forms of forensic evidence - e.g. DNA, fingerprinting, blood drug alcohol measurements - are founded on statistical models and statistical reasoning.

Many lawyers regard DNA and other expert evidence as based on fool proof scientific models that provide certain results. It must be emphasised that this type of evidence actually involves a significant amount of subjective reasoning and uncertainty.

There are case studies of understanding. However, a proper answer to this question would require good quality analysis of reports and judgements.

For juries, the evidence available is restricted by what it is legal to collect about deliberations.

Communication between scientists, lawyers and the judiciary is critical in promoting mutual understanding and to improve effectiveness. As well as shared written material (the initiative on Judicial Primers and the Inns of Court booklet are good examples of this- see below), regular face-to-face discussions or question and answer sessions, and easy access between actors are important.

6. Is the current training available in statistics for practitioners, lawyers and the judiciary appropriate?

No. Various guides and primers have been published:

- practitioner guides by the RSS (www.rss.org.uk/practitioner-guides)
- an advocates guide jointly by the RSS and Inns of Court College of Advocates (<https://www.icca.ac.uk/expert-evidence>)
- and judicial primers by the Royal Society, the Royal Society of Edinburgh.

Some statistical content is needed in training for solicitors, advocates and judges. The RSS could assist in assessing the quality of such training.

An RSS Statistics and Law Section (SLS) interdisciplinary colloquium on the use of epidemiology in tort law agreed unanimously that more interdisciplinary training was crucial to the task of ensuring effective and appropriate use of statistical evidence.

The RSS SLS is already planning to offer separate training courses for lawyers and statistical experts on the use of statistical information in personal injury litigation. This is an objective for the medium term as it will take considerable resources to design and deliver such courses, and funding will be essential.

Standards and regulation

7a. Is the current market for forensic services in England and Wales sustainable?

The market, as it is, is not sustainable; see e.g.

Regarding commercialization: Jackson G., The impact of commercialization on the evaluation of DNA evidence, *frontiers in Genetics* (doi: 10.3389/fgene.2013.00227)

A centralised controlled public Forensic Science Service would be better than private companies where validation and standardisation is not always in place.

Relying on the private sector implies cost-cutting, which can (and has for blood drug levels) lead to failure of justice.

Joint work with the Forensic Science Regulator on blood drug and alcohol levels has found inappropriate statistical analysis.

Other work has found substantial within and between laboratory variation in results.

Failure to present the value of combining several elements of scientific evidence is inefficient, and risks of miscarriages through the provision of misleading evidence.

8. Is the system of accreditation working successfully to ensure standardised results and the highest quality analysis and interpretation of significance of evidence?

Accreditation through UK Accreditation Service (UKAS), and the guidance offered by the Regulator, of methods and equipment aims to ensure standardised "results".

It is much harder to set agreed standards, to monitor performance and to enforce remedial actions for subjective, expert interpretation and evaluation. Current accreditation is therefore limited.

Forensic experts and performance of laboratories need to be validated and tested for reliability by appropriate validation studies. These studies must be conducted by external bodies, using known source samples in order to provide false positive and false negative rates for each laboratory and expert.

Models, software and data used both for validation studies and in real cases should be made available for examination and should be clearly explained in the expert's report. Black-box methods should not be allowed.

9. What role should the Forensic Science Regulator have?

The Regulator should have statutory powers to set standards of performance, to monitor performance and to take action against failures to comply.

The powers should include a required format for reports, reporting of data collection, cleaning and validation for data bases, and missing or poor quality results for forensic samples.

10a. What lessons can be learned from the use of forensic science in Scotland and Northern Ireland?

The Scottish system is still based on a publicly funded system with similar budgetary constraints to England and Wales. We are not aware of any publicly available data that would compare the performance of the Scottish system with that in England and Wales.

10b. What can be learned from the use of forensic science overseas?

Seen from continental Europe, there has been a loss of an established institution (FSS) with a profound body of knowledge. Now research seems scattered among different actors (mainly academic), as commercial providers might have other priorities and limited resources to invest in fundamental research.

11. Is the 'Forensic Science Strategy' produced by the Home Office in 2016 suitable?

This was a noble attempt to align forensic science activity with the perceived needs of the primary user (in this case, the police). However, it falls short of a coherent framework for the future.

Forensic Science research landscape

12a. How should further research funding for forensic science be justified?

Research should be justified on two levels: a) to meet the immediate and medium-term needs of the primary client and wider stakeholders; b) to explore new techniques and methods that may help law-enforcement and civil litigation.

The cost of failed prosecutions, miscarriages of justice and the benefits of effective deterrents should be considered.

12b. What should be the focus of such research?

Research effort in forensic science must be driven by the needs of the primary clients and wider stakeholders on the basis of open dialogue between practitioner forensic scientists, clients, stakeholders and academia.

Improvement in quality control checks: the quality of data used, validation of methods, and evaluation and interpretation of evidence.

Development and dissemination of cost effective methods for quality control, for example, the use of efficient sampling plans and models for sources of variation is required.

Research is also needed on the issue of adversarial bias: the phenomenon where an expert, either consciously or unconsciously, feels obligated to provide a report that supports the position of hiring legal team.

Funding for the design and creation of national databases, including the data collection and data management aspects, with the aim of creating a robust resource that could be accessed by scientists for testing and validating evidence evaluation models and algorithms. The involvement of statisticians and scientists from the relevant disciplines would ensure that the bias currently arising from the use of convenience samples is reduced.

12c. What is the role of UK Research and Innovation, especially considering the interdisciplinary nature of much forensic science?

Some centralised body is needed to coordinate forensic science research. Research in this area is very interdisciplinary and a framework links between the various disciplines is necessary. Offer funding mechanisms for interdisciplinary projects which do not fit traditional RC models. For example, statisticians can struggle to get data and forensic scientists can struggle to get advice on statistics, databases and interpretation.

Provide support for networking events with scientists and relevant professionals on the identification of problems and concerns, how these might be addressed and the order of priority.

Ensure that applications meet the highest standards of statistical design and analysis required by any of former RCs, e.g. MRC has statistical referees and on statisticians on panels.

13a. Where are the gaps in research and understanding of forensic science?

Creation and evaluation of specialist and national databases.

Appropriate methods for validation, evaluating and interpreting evidence.

Review of the quality of software and algorithms used.

13b. How and by whom should the research questions be articulated to fill these gaps?

Civil litigation is almost always overlooked in discussions about forensic evidence.

A significant amount of scholarly research has already identified core problems associated with the use of statistical evidence in personal injury litigation.

Lists of questions from providers, barristers, judges, and forensic scientists as well as the regulator could be sought. Either the Royal Society of Edinburgh and the Royal Society, or UKRI could then develop a coherent framework for next few years.

14. How can a culture of innovation in forensic science be developed and sustained?

Open, effective dialogue between provider and users; providers who are motivated to invest in research and development. Better financial support.

15a. Are there current or anticipated skills gaps?

Data management, statistics, data science

15b. Who should have responsibility for and have oversight of training?

The RSS would be a good body to have oversight of training in statistics. Such responsibility implies having sufficient resources.

Digital Forensics

16. Are there gaps in the current evidence base for digital evidence detection, recovery, integrity, storage and interpretation?

No comment.

17. Is enough being done to prepare for the increasing role that digital forensics will have in the future?

Anecdotally, it would seem police and forensic science providers are close to being overwhelmed by the actual or potential demand.