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Preventing miscarriages of justice: A review of forensic firearm identification

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ABSTRACT

The role of a firearm examiner is wide ranging, involving tasks that require scientific understanding in aspects of chemistry, physics and biology. This article aims to provide a critical review of the key scientific principles and practices specifically involved with forensic firearm identification and to discuss how misidentifications have resulted in cases of injustice. Implementation of quality assured examination practice, demonstration of individual examiner competence and more objective methods of reporting are being adopted by firearm examiners and laboratories to address some of the criticisms relating to subjectivity and standardisation inherent within the discipline. The impact of these changes is outlined and further recommendations are made for both examiners and legal professionals to minimise the potential for future injustices involving firearms evidence. Latest research in the field is cited, continuing to support the theory and use of firearm identification as admissible evidence in court.

1. Introduction

Between 2008 and 2009, a number of reports were published [1–3] regarding the position of forensic science, current issues and the recommendations that need to be made in specific forensic disciplines going forward. Of these, the National Academy of Science (NAS) report [2] has been the most widely cited reference, especially referred to by legal professionals and the media, to criticise and undermine work undertaken by forensic practitioners when applying their scientific interpretations and discipline knowledge to casework in the pursuit of justice. In particular, this report identified concerns regarding the scientific underpinning of pattern recognition based disciplines such as fingerprints, firearms and questioned documents. These fields were highlighted due to the perception that there were limited published research and documentation to support the validity and reliability of the science and the interpretations made following forensic analysis.

In response to the NAS [2] report, the American Society of Crime Laboratory Directors (ASCLD [4]) identified the two fundamental issues highlighted by NAS; 1) the lack of standardisation of procedure across laboratories within disciplines and 2) the need for more resources, education and training for practitioners to carry out casework. Both of these issues are typically caused due to the lack of stable and sufficient funding in the United States (US). However, these issues apply in other countries worldwide and are significant causes of miscarriages of justice (Section 2), negatively impacting confidence in forensic evidence presented in court. The ASCLD [4] response therefore highlights the need for experts in the forensic community to be fully prepared to answer questions in the courtroom and provide evidence to document, justify and support the scientific underpinning and validity of the analytical methods utilised within their disciplines.

Other organisations, such as California Association of Criminalists (CAC [5]) also responded to the NAS report, with only non-expert reports such as the National Association of Criminal Defense Lawyers (NACDL [6]) predominantly agreeing with the NAS [2] report outcomes. The ASCLD response [4] highlights that to change these perceptions the discipline experts need to engage and collaborate with non-experts, such as legal professionals, to communicate the science underpinning our fields. Although, to achieve a successful outcome this engagement needs to be a two way process. Professionals using information provided by subject experts need to ask the right questions to ensure their understanding of the capabilities and limitations of the science and interpretation supporting casework is presented in an unbiased way to those in the courtroom, especially jurors.

One of the most basic and fundamental issues experienced by this field is the common misuse of the term 'forensic ballistics' to holistically cover the three core disciplines; forensic firearm examination, firearm identification and ballistics. These three areas are quite separate scientific concepts for which different articles could be written. Forensic firearm examination covers the examination of firearms to evaluate their forensic value and establish their functionality. Forensic firearm identification involves the comparison of fired ammunition components to test fired exemplars from a suspected firearm. Ballistics relates to the motion of the projectile from the time the ammunition is fired until

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the moment it comes to rest. Ballistics is further sub-divided into three key areas; internal (everything that happens to the projectile before it leaves the weapon), external (the motion of the projectile as it is travelling through the atmosphere) and terminal ballistics (the motion of the projectile once it comes into contact with matter of any kind). Intermediate ballistics is sometimes considered as an additional component of ballistics that covers the motion of the projectile just as it exits the muzzle of the barrel until it escapes the flow of gases and enters free flight. The identification of gunshot residue (GSR) as coming from firearm ammunition using analytical chemistry techniques such as scanning electron microscopy and energy dispersive x-ray (SEM EDX) is an additional area of expertise sometimes considered within 'forensic ballistics'. Firearm examiners are typically not qualified to identify primer particles as being GSR, however, they may be asked to interpret GSR evidence from unburnt and partially burnt gunpowder to estimate shooting distances.

The field of firearms and ballistics is extensive and truly multidisciplinary, requiring the firearm examiner to be knowledgeable and demonstrate depth of understanding across all three core sciences (chemistry, physics and biology) and apply mathematics to compare, analyse, interpret and link shooting related incidents. Typical tasks that a firearm examiner may be asked to carry out and be called upon as an expert witness are summarised in Table 1. However, it is important to appreciate that a single firearm examiner may not have the training and experience to carry out all of these roles due to the broad nature of the discipline. Tasks associated with firearm examination and function testing, legal classification and firearm identification may be considered the more common skills. Shooting incident reconstruction and serial number restoration may be considered as specialised areas of the field.

There are numerous recommended textbooks [7–11] designed for reading by both laypeople and experienced examiners, which discuss each of these scientific areas in significantly greater depth. The purpose of this article is therefore not to summarise those already written, but to provide a critical reflection on the causes of miscarriages in justice (Section 2) in the area of forensic firearm identification (Section 3) and discuss how professionals are trying to minimise the occurrence of these occurring in the future (Section 4).

2. Miscarriages of justice

Miscarriages of justice are undoubtedly damaging to the lives of those wrongfully convicted, the victim of the crime as well as the families, friends and associates of these parties. In comparison to the number of those correctly and successfully convicted for the crimes they have committed, known injustices are typically infrequent. The criminal justice system and criminal proceedings involve a number of key parties who all have a role to play in ensuring that the outcome is appropriate to the gathered evidence and intelligence presented in the courtroom. Expert witness evidence is only one element of this wide network of individuals. The judge, lawyers (both prosecution and defence) and importantly the members of the jury (if applicable) are all pivotal and responsible for reducing the probability of a miscarriage of justice occurring, however, this chance will never be eliminated. The judge should act as gatekeeper to ensure only appropriate expert witnesses present admissible evidence and legal counsel need to ensure they do not make assumptions about the work undertaken by the expert. When undertaking cross-examinations counsel should fully question the procedures and outcomes presented and should examine the expert's training, experience and competence prior to and during proceedings.

Over recent years there has been more emphasis and importance realised in the legal community about the requirement for them to become educated and understand the science underpinning forensic evidence. The jury however, do not have this luxury and therefore it is critical that those involved with cross-examination and presentation of expert testimony in court provide opportunities for experts to communicate the necessary science effectively to laypersons. Such communication needs to be to an extent whereby each juror sufficiently understands the evidence, how it has been interpreted and the significance of the interpretation in the context of the case. Jurors get limited opportunities to clarify their understanding of scientific evidence and therefore it is vital that legal counsel ask expert witnesses the right questions to ensure that jurors correctly interpret and weight the information presented to them by both the prosecution and defence.

Due to the limitations of firearms evidence (Section 3), a specific person under suspicion for a crime cannot be attributed by analysis of firearms evidence alone. This means that information provided by firearms evidence is typically corroborative rather than conclusive; there must be other forms of physical or intelligence-based evidence to increase the probability that one particular individual was more likely to have committed the crime than another. Each case of miscarriage of justice may therefore involve a number of contributing factors that resulted in an incorrect verdict, not just related to the interpretation of firearms evidence. For example, in a case where a suspect weapon is recovered and can be test-fired for comparison against recovered crime

Table 1
Tasks potentially requested to be undertaken by a firearm examiner.

Task	Purpose(s) of task
Firearm classification	Identify the legal classification of a firearm (or component) within the local region's firearms legislation to determine whether any charges should be brought by law enforcement for the possession of a firearm
Function testing	Determine whether the firearm is functioning as per manufacturer's design, whether it has been modified or converted, deactivated or reactivated and/or the capability of accidental discharge
Firearm restoration	Restore a firearm to its functional order so that the weapon can be test-fired
Serial number restoration	Recover obliterated serial number(s) on the firearm components, which can determine the date of manufacture, and trace the current and previous owner of the firearm
Test-firing	Create fired ammunition components (e.g. bullets and/or cartridge cases) from a known firearm for reference and forensic comparison purposes
Forensic firearm identification	1. Identify whether fired ammunition components recovered from a crime scene have been fired from a specific suspect weapon by comparing to known reference samples test-fired from the weapon 2. Determine the number of firearms used in a shooting incident 3. Link crime scenes together by comparing fired ammunition components (evidence samples) from multiple scenes
Firing angle determination	1. Identify the angle of the projectile impact (e.g. using bullet hole or ricochet mark) 2. Identify the direction of the projectile impact 3. Determine the possible firing location
Muzzle-to-target distance estimation	Estimate how far away (range) the muzzle of the gun was positioned from the target/victim by comparing known results from simulated crime scenes
Trajectory analysis	1. Estimate the range of fire and thus determine where the projectile (e.g. bullet) may be located 2. Determine the firing location 3. Establish whether the firing location is consistent with the terminal location of the projectile 4. Confirm or refute eyewitness testimony