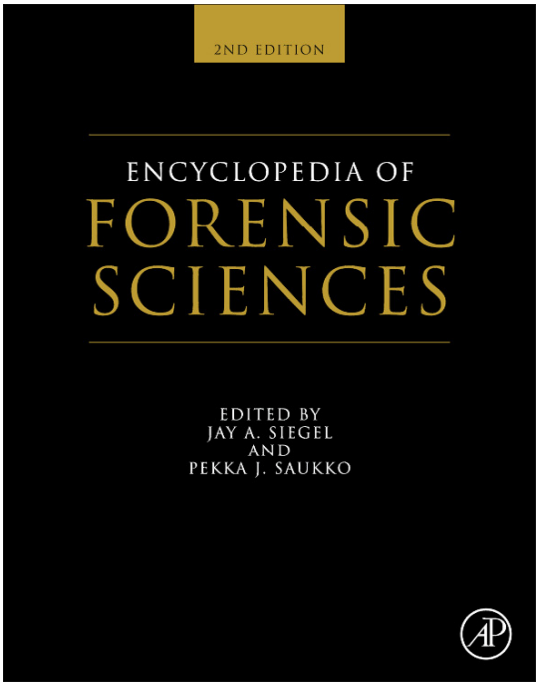

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Standard Methods

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Glossary

ANZPAA Australia & New Zealand Police Advisory Agency
ASCLD American Society of Crime Laboratory Directors
DIS Draft International Standard
DNA Deoxyribonucleic acid
ENFSI European Network of Forensic Science Institutes
EU European Union
FAD Field Application Document
IEC International Electrotechnical Commission
ISO International Organization for Standardization
NATA National Association of Testing Authorities
NIFS National Institute of Forensic Science
PAS Publicly Available Specification
SMANZFL Senior Managers of Australia New Zealand Forensic Laboratories
UKAS United Kingdom Accreditation Service

Introduction

Forensic science has made a significant contribution to the investigation of crime and the administration of justice and is well established within these processes. Additionally, in recent years, popular media have substantially increased the profile of the field. Reliance on forensic science for the purposes of identification has also been highlighted globally by its application in the aftermath of mass disasters and terrorist acts, with forensic technologies being widely applied to the identification of victims and, in the case of terrorist attacks, identification of the perpetrators.

While the contribution that forensic science makes to reliable justice outcomes is undeniable, its application requires a thorough understanding of the discipline being applied and its potential pitfalls. Similar to any tool in the investigator's kit, without the requisite expertise and relevant support systems, forensic results may be misapplied or results misinterpreted.

In order to minimize the risk of errors, forensic facilities have developed a quality assurance program for all forensic processes. The relationship between the forensic process (the application of scientific methodology within a laboratory) and quality assurance processes (accreditation, certification, and standardization) is demonstrated in Figure 1.

Forensic laboratories seek accreditation from testing authorities to ensure compliance with national or international standards for laboratory practice. As part of this compliance, laboratories have documented practices and procedures (methods) that specify the conditions under which examinations shall be applied, conducted, interpreted, and reported. These methods should be based on published peer-reviewed research and subject to in-house validation or verification.

Forensic practitioners themselves require some form of certification, either through authorization by their facility to carry out specific classes of examination and analysis (the methods) or through qualified membership to a group or society. Certification schemes usually require ongoing assessment of the practitioners' performance within their areas of expertise.

Although each laboratory maintains a quality assurance program, variations in practices and procedures are not uncommon. In addition, in circumstances where a particular specialized expertise not available through an accredited forensic facility is required to assist in an investigation, investigators may seek the services of experts from other service providers such as a University, Museum, or private forensic service provider. Such services may fall outside the established quality controls that exist in forensic facilities, and therefore, may be unlikely to be covered by accreditation or certification. This may also result in variations in practice.

Such variations may impact on the results obtained from an examination, or the way a result is interpreted and reported to an investigator or a court of law. The ramifications of variations may be significant: a perpetrator may escape justice or an innocent person may be unjustly punished.

The increased exchange of forensic evidence and information between states and nations highlights the role of common standards for forensic service providers in order to avoid uncertainty regarding the way in which an item has been handled, the methods that have been used, and how the results have been interpreted. The use of standards ensures the continuing reliability and quality of forensic science at an international level.

Why Standards Are Required?

Unreliable justice outcomes damage public faith in the legal system and may also lead to legal challenges as to the accuracy of forensic evidence. In the following case studies, the focus is on cases involving DNA evidence; however, the implications of the cases with respect to the lack of national or international standards are more generally applicable to forensic science practice and procedures. A review of these cases illustrates that the failings have generally been the result of breakdowns in processes or procedures, and not of failures of the scientific technique.

Case Study 1

Over a 7-year period, millions of Euros and hundreds of thousands of police hours were spent searching for a female suspected serial killer in Europe. The suspect was linked through DNA matches between a series of 40 crime scenes in Germany,

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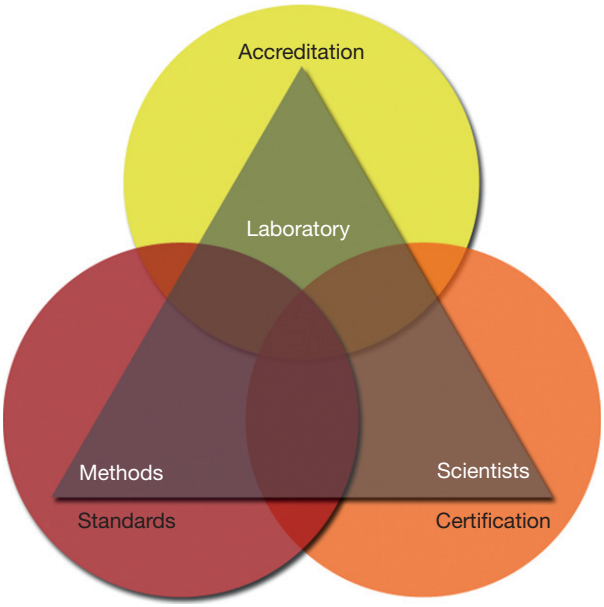

Figure 1 Relationships between the forensic process and quality assurance program, outlining the role of standards.

Austria, and France. The DNA was linked to the murder of a female church warden in 1993, the murder of a 22-year-old policewoman in 2007, and the execution-style killings of three Georgian car dealers. Suspicions regarding the possibility of contamination arose when the number and diversity of linked crimes increased. Many of the cases were solved, but no female suspect with a matching DNA profile could be located. The initial doubts were confirmed when the same DNA profile was found during an investigation into the identity of a burned body in France that was thought to belong to an asylum seeker who had disappeared in 2002. Using swabs (pooled together) of the missing man's collected fingerprints, the DNA was extracted to produce a profile that was found to match the female suspect's DNA profile from the linked cases. Investigators began to suspect that batches of cotton swabs had been contaminated with DNA from an unknown source during the manufacturing process. Further products have since been identified as having contaminations resulting from the manufacturing process. The supposedly uncontaminated sterile swabs are used by police forces in several European countries.

Case Study 2

In 2006, a 48-year-old woman fell unconscious in a nightclub in Melbourne (Australia). Although she had no memory of being sexually assaulted, there were concerns that she may have been drugged and assaulted. Vaginal swabs were collected from the alleged victim at a designated facility in a hospital. When analyzed at a forensic laboratory, a DNA match was reported that linked biological material on the alleged victim's sample to the reference DNA profile from an earlier incident involving a 19-year-old male (although this earlier incident was determined as no offense having occurred). Police investigating the matter became concerned that there was no supporting evidence to link the male suspect to the alleged victim and queried the laboratory about the possibility of cross-contamination between the two cases. The forensic facility discounted the possibility on the basis of the two samples being examined by different technicians, at different times, and in different areas of the laboratory, and of their being processed in different batches. At the trial, the young male was convicted of the sexual assault and sentenced to 6 years imprisonment. The case was appealed. The prosecution investigation, in preparation for the retrial, revealed that the DNA samples relating to the earlier case were collected approximately 28 h before the alleged victim's vaginal swabs were collected, and by the same doctor in the same examination room within the same designated facility. It was at this point that the high possibility of contamination of the alleged victim's vaginal swab was realized and a subsequent inquiry found that contamination at the point of sample collection in the hospital was the most likely explanation. When the matter came before the court in 2009, it was accepted that a miscarriage of justice had occurred and a verdict of not guilty was entered.

The cases above provide examples where compliance with national or international forensic standards could have a role in minimizing the avoidable waste of investigational resources and poor justice outcomes. While there may be variations in practices across jurisdictions based on the legal environment and technical application, the scientific basis for the methodologies and procedures that are utilized is universal. This universal approach should apply to the entire forensic process, from the identification and collection of items and samples, including packaging and sample integrity, through to analysis, interpretation of results, and reporting. This is where defined forensic standards can provide guidance in acceptable practice for scientists, and confidence in the expert opinions provided for the judicial process.

The United States National Academy of Sciences Report 2009

The report published by The National Academy of Sciences in 2009, (under a direction from US Congress) '*Strengthening Forensic Science in the United States: A Path Forward*' (the 'NAS Report'), highlighted problems that existed in the field of forensic science within the United States and called for the establishment of a National Institute of Forensic Science to develop forensic science standards to address the identified problems.

Although the NAS Report focused on the situation with respect to forensic science practice in the United States, it is obvious that the issues identified and recommendations provided apply globally and have implications for all forensic practitioners.

In particular, the NAS Report stated that operational principles and procedures for many forensic science disciplines were not standardized, either between or within jurisdictions. Furthermore, where protocols aimed at facilitating consensus are in place, such as Scientific Working Group standards, they are not intended to be enforceable. This is seen to pose a threat to the quality of forensic science practice, reinforcing the need for systematic changes, including establishing enforceable standards, to promote best practice, ensure consistent outcomes and reliability of forensic science as a whole. Many disciplines have already taken steps to identify where improvements in their fields can be made.

The Purpose of Standards

Standards provide guidance and set out specifications and procedures that ensure that products, services, and systems are reliable and perform consistently to an expected level, and that confidence can be placed on their outcomes. They are regularly reviewed to ensure that they keep pace with new technologies.

As voluntary consensus documents the application of standards is by choice unless their use is mandated by government or specified by a contract. Standards may also be applied by means of a voluntary industry code, or by quasi-regulation such as a standard endorsed by government.

Standards are intended to be practical. While they may exceed the minimum expectations of performance or practice, they are not intended to be difficult to comply with, based as they are on sound scientific principles, the experience of practitioners, and the expectations of the end user.

Standards define the level of expectations for a quality service. In the case of forensic standards, the end users are usually law enforcement agencies and the justice system, but the outcome of any investigation or trial impacts on society, either as a whole or as individuals. Society has an expectation that services and products comply with national or international standards; forensic science laboratories should not be exempt from the same expectations.

Advantages of Recognized Forensic Standards

Forensic science standards provide the following benefits:

- consistency of practice within laboratories;
- consistency in procedures across laboratories and agencies;
- defined standards of reliability and quality for all forensic practitioners;
- standard practices that private practitioners, smaller agencies, and institutions will be able to refer to in order to ensure that their work meets the required standard for acceptance in a judicial setting; and
- judicial confidence in forensic science laboratory output.

Compliance to a platform of relevant standards for forensic science disciplines ensures that methodologies are robust, repeatable, and validated, and that training as well as experience across laboratories is consistent. This has a direct bearing on the quality of scientific evidence presented in the courts, and reduces the risk of poor justice outcomes, such as exemplified in the case studies mentioned previously. Consistent and accepted forensic standards will benefit all users of the judicial system, including members of the public as well as investigators, legal practitioners, and forensic scientists.

Recognized standards facilitate professional mobility. This is a direct consequence of standards and standardization. Professional mobility has many advantages in times when a rapid response is required to scenes of major crime or disaster, which is beyond the means and capabilities of any one laboratory (e.g., multiagency responses to mass disasters or terrorist acts). Besides reducing resource requirements, this also enhances forensic capacity and capability, and the development of individuals and forensic disciplines.

The existence of forensic science standards benefits smaller specialized forensic service providers and individual practitioners who provide niche forensic services to the public and the judicial system. These service providers are often unable to meet the cost of external accreditation and are looking for guidance in developing procedures and protocols that would ensure legal acceptability and consumer confidence, within the constraints of their environment. Forensic science standards provide the guidance in developing practices and procedures that specialized service providers require.

Forensic science standards reduce the risk of miscarriage of justice and, therefore, have the potential for significant savings to society with respect to the costs of retrials or other litigious processes. Additionally, standards reduce the duplication of effort that occurs in establishing concurrent methodologies.

Global Standard Environment

International Standards

Accreditation helps establish trust in the validity of the basic analytic methods used in forensic laboratories by offering evidence that laboratory activities are performed in accordance with relevant standards and applicable guidelines. Most accredited forensic laboratories are assessed against ISO/IEC 17025 'General requirements for the competence of testing and calibration laboratories,' published by the International Organization for Standardization (ISO). The objective of this Standard is to specify the general requirements for the competence of a laboratory to carry out tests and calibrations, including sampling, performed using standard, nonstandard, and laboratory-developed methods. Although specific in parts, the requirements of ISO/IEC 17025 are generally at an organizational level and specify laboratory management requirements, with an emphasis on policy and documentation. As such, ISO/IEC 17025 does not address the requirements for sampling and testing in a forensic laboratory that serves the justice system. To address this gap, some accreditation bodies have developed field application guides that provide specific guidance to forensic laboratories; however, the focus of such guides is on laboratory procedures rather than crime scene procedures. The International Laboratory Accreditation Cooperation (ILAC) is an international cooperation of accreditation bodies, which promotes and harmonizes laboratory and inspection accreditation practices. ILAC also publishes guidelines for forensic science laboratories in the application of ISO/IEC 17025.

In the absence of any specific standard covering the collection and examination of material for forensic purposes, The United Kingdom Accreditation Service (UKAS) is developing accreditation for the scene of crime investigation against the international standard ISO/IEC 17020 – General criteria for the operation of various types of inspection bodies performing inspection. The use of ISO/IEC 17020 for forensic accreditation takes the relevant aspects of the Standard and applies it to crime scene investigations. However, although ISO/IEC 17020 may be generally applicable to crime scene examination, it is unlikely that it can be extended to forensic laboratories as it is aimed at criteria for inspection bodies

in the examination of 'materials, products, installations, plant, processes, work procedures, or services' to provide certification.

ISO/IEC DIS 27037: Information technology – Security techniques – Guidelines for identification, collection, acquisition, and preservation of digital evidence.

In 2008, the ISO/IEC Joint Technical Committee commenced the development of a standard for 'Evidence Acquisition Procedure for Digital Forensics,' which will provide detailed guidance on the acquisition of electronic evidence and subsequent maintenance of its integrity. It will define and describe the process of recognition and identification of the evidence, documentation of the crime scene, collection and preservation of the evidence, and the packaging and transportation of the evidence. The aim of the standard is to provide guidance to law enforcement and digital (computer) forensic scientists to maintain the integrity of electronic evidence required for extradition between law enforcement agencies across national borders. The standard will also provide guidance to private companies that have to preserve electronic evidence to assist criminal investigations by law enforcement agencies.

North America

In the United States of America, over 385 crime laboratories are accredited by the American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB), including federal laboratories, state and local agency laboratories, as well as private laboratories. Since 2004, ASCLD/LAB has provided accreditation under the ASCLD/LAB-International Accreditation Program that is based on ISO/IEC 17025, supplemented by forensic specific requirements. Since 2009, all new applications for accreditation are assessed against ISO/IEC 17025 although approximately half of the accredited laboratories continue to be assessed against a legacy system.

ASCLD/LAB also accredits forensic facilities outside the United States, including facilities in Canada, Hong Kong, Malaysia, New Zealand, and Singapore.

ASTM International (formerly known as the American Society for Testing and Materials – ASTM) publishes a range of forensic standards. ASTM is currently harmonizing their standards with ISO. The ASTM approach to forensic standards (through the work of the Committee E-30) has produced widely recognized documents as guidelines for practice or specific forensic methods. As guidelines, ASTM standards do not necessarily hold the same authority as a standard and can be quite prescriptive regarding specific processes or application. In addition, numerous ASTM forensic standards include processes that are common to many forensic disciplines (such as exhibit collection, storage, analysis, and reporting results) and, therefore, the scope and procedures covered often overlap to a significant extent.

United Kingdom

The UKAS is the sole national accreditation body recognized by the UK government to assess, against internationally agreed standards, organizations that provide certification, testing, inspection, and calibration services. Forensic laboratories in the United Kingdom are accredited by UKAS against ISO/IEC 17025.

British Standards Institution, the National Standards Body of the United Kingdom, released a Publicly Available Specification (PAS) for forensic kits. in 2012. PAS 377: Consumables used in the collection, preservation, and processing of material for forensic analysis – specification for performance, manufacturing, and forensic kit assembly.

The Forensic Science Regulator sets quality standards for forensic science used in the criminal justice system in England and Wales. The Regulator continues to publish quality guides for forensic science although the guides are not published as Standards and, therefore, do not hold the same authority.

Manual of Regulation Part One: Policy and Principles (published for consultation): sets out the high-level principles proposed by the regulator and the methods by which the regulator intends to set and monitor quality standards in the delivery of forensic science evidence to the criminal justice system.

Codes of Practice and Conduct for forensic science providers and practitioners in the Criminal Justice System: the code of practice and conduct is based on the good practice that accredited providers are already required to demonstrate under ISO/IEC 17025.

Developing a Quality Standard for Fingerprint Examination: This position paper sets out the initial views of the fingerprint quality standards specialist group, indicates that quality standards must be developed for fingerprint examination to address the known risk of human error in this cognitive discipline.

Europe

In 2009, in order to step up cooperation in combating terrorism and cross-border crime, the European Union adopted an Act under the EU Treaty on accreditation of forensic service providers carrying out laboratory activities to ensure that forensic service providers carrying out laboratory activities are accredited by a national accreditation body as complying with ISO/IEC 17025. This Act provides a legally binding instrument on the accreditation of all forensic service providers carrying out laboratory activities for the analysis of scientific evidence.

The European Network of Forensic Science Institutes (ENFSI) is recognized as an expert group in the field of forensic sciences, which aims to ensure the quality of forensic science throughout Europe and publishes best practice manuals and glossaries of forensic terms. ENFSI encourages laboratories to comply with best practice and international standards for quality and competence assurance.

Australia

The National Association of Testing Authorities (NATA) accredits all Government laboratories against ISO/IEC 17025. To support ISO/IEC 17025, NATA developed a Field Application Document (FAD) for forensic science laboratories. The FAD provides guidance to forensic laboratories in the application of ISO/IEC 17025, but does not address the standardization of specific processes and procedures. Specific requirements, such as sample recognition and collection at a scene, appropriate sample packaging and labeling, transport of forensic samples, sample continuity, examination and interpretation of results, reporting evidence of fact or opinion evidence, are not specifically covered in either ISO/IEC 17025 or the FAD.

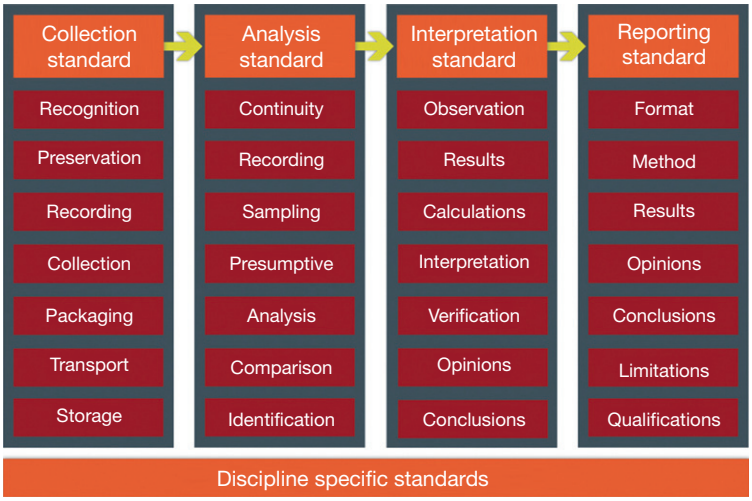

Figure 2 The 'core' forensic standards cover the universal aspects of forensic science practice.

Owing to a number of inadequate justice outcomes that impacted negatively on the perception of the field of forensic science, the Senior Managers of Australia New Zealand Forensic Laboratories (SMANZFL) recognized the need for a suite of agreed national forensic standards. SMANZFL, working with the Australia New Zealand policing Advisory Agency National Institute of Forensic Science (ANZPAA NIFS), developed a framework for forensic science standards via Standards Australia.

Standards Australia is recognized by the Australian Government as the peak nongovernment Standards body in Australia, develops internationally aligned standards, and is a participating member of ISO and IEC.

The Standards Australia Forensic Analysis Committee (CH-041) was established by Standards Australia in 2009. It comprises representatives from stakeholder organizations: law enforcement, forensic facilities, judicial representatives, ANZPAA NIFS representatives, educators, and testing facilities from around Australia.

The core forensic standards provide a comprehensive framework of forensic science standards that are applicable to the majority of forensic science disciplines:

- AS 5388.1 Forensic Analysis Part 1: Recognition, recording, recovery, transport, and storage of material;
- AS 5388.2 Forensic Analysis Part 2: Analysis and examination of material;
- AS 5388.3 Forensic Analysis Part 3: Interpretation; and
- AS 5388.4 Forensic Analysis Part 4: Reporting.

The core standards can then be supported by the development of discipline-specific forensic science standards in the future, referencing the core standards for the more universal aspects of forensic science practice such as collection of forensic material, examination techniques, interpretation of analytical results, and reporting of findings (see Figure 2).

Challenges in Developing Standards

Standards are not designed to replace procedure documents, laboratory methods, or facility policies. Therefore, the challenge is to produce standards that are not prescriptive with respect to methodology, but recognize the existing accepted practice and define the expectations of reliability and consistency of the results that are obtained and reported.

In the forensic environment, this can be achieved by defining:

- the requirements for protecting the integrity of forensic material from its recognition and collection, and through subsequent analysis stages;
- the appropriate recommended practices and procedures that may be applied to the examination and analysis of forensic material;
- the required performance parameters for analytical techniques;
- the way various analysis and examination results shall be interpreted; and
- the appropriate wording to use when reporting results, conclusions, and opinions.

By not specifying detailed analytical methodology or examination procedures, standards allow practitioners to determine the appropriate method to apply to a particular forensic process, according to the practice and procedure documents approved by their facility, while still fulfilling the requirements of a standard for reliability and consistency.

Agreed standards ensure robust, reliable, and consistent results and are an important part of the quality system globally. The development of forensic standards ensures the continuing reliability and quality of forensic science and the continued confidence of investigators and the courts.

Acknowledgment

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See also: **Legal:** DNA Exonerations; Legal Aspects of Forensic Science; The Innocence Project; When Science Changes, How Does

Law Respond; **Management/Quality in Forensic Science:** Accreditation; Certification; Principles of Quality Assurance; Risk Management.

Further Reading

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