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Impact of forensic science in criminal justice: The role of research and development in the study of forensic science

Javaid Talib[1], Naseem Tabrez[2]
[1] Professor, Department of Law, Aligarh Muslim University, Aligarh, Uttar Pradesh, India
[2] Research Scholar, Department of Law, Aligarh Muslim University, Aligarh, Uttar Pradesh, India

Abstract
This study makes an attempt to explore that Forensic science is the ratifications of the full range of science to questions relevant to a legal system, usually in relation to either criminal or civil action. It is crucial for the smooth working of the criminal justice system, for fighting crime and combating terrorism. Research underpins the practice of forensic science to support its development, increase its value to the criminal justice system and enhance the precision with which forensic evidence is collected by legal agencies, processed by forensic service providers, and presented to the court.
Researchers analysed the role of forensic evidence in solving five felony crimes (aggravated assault, burglary, homicide, rape and robbery) in five jurisdictions. Overall, the findings suggested that law enforcement officers determined which forensic evidence from crime scenes would be sent to the laboratory for analysis. In this study, the role of forensic science in research and development has come at an opportune moment in the current environment of austerity and rationalisation of services. The ability to respond in a co-ordinated manner to issues within the criminal justice system utilising science and innovation is crucial to the prevention and detection of criminal activity.
It is a prudent attempt to make an effort with a view to appraising the existing laws and the institutions of the country dealing with the criminal justice system so that the scope of the role of forensic science therein can be analysed. This review has consciously taken a broad view of forensic science to understand the scope of relevant research, as well as its location, motivation, funding, and contribution to law enforcement and the criminal justice system.

Keywords: forensic science, national institute of justice, criminal justice system, law enforcement agencies, forensic laboratories, research and development

Introduction

Forensic science is a multidisciplinary subject for examining crime scenes and gathering evidence to prosecute offenders in of law. It is also used to examine consent with international agreements regarding weapons of mass destruction. In other words, forensic science is the use of science in the service of the law. Forensic scientists are experts in any technical field who provide an analysis of the collected evidence, witness testimony on examination results, technical support and even training in their specialised area. Analysis of forensic pieces of evidence is used in the examination and prosecution of civil and criminal cases. Often, it can support establishing the guilt or innocence of possible suspects. Forensic testimony is also used to link crimes that are thought to be related to one another. For instance, DNA evidence can link one offender to many different crimes or crimes scenes. Linking crimes help law enforcement authorities narrow the range of possible suspects and build patterns for crimes, helping identify and prosecute suspects. The forensic expert also works on building new techniques and procedures for the collection and analysis of evidence. In this pattern, new technology can be used and refined to keep forensic scientist on the cutting edge of science and uphold supreme quality and accuracy[1].
Forensic science has evolved to play a prominent part in the investigation of serious crimes. One of the first vital developments was identification via fingerprints. It was discovered in the 19th century that almost any contact between a finger and a fixed surface leaves a latent mark that could be exposed by a variety of procedures, the most common being the use of a fine powder. It was accepted in 1893 that no two individuals had the same fingerprints, and this proportion has never been seriously challenged. IN almost all countries, police forces maintain collections of fingerprints taken from known criminals when their conviction is to identify these individuals should they commit later crimes. (Agrawal, S.G. Allahabad: 2013, P. 155.)
Over the years, the forensic sciences have made dramatic scientific breakthroughs (DNA typing, physical evidence databases, and new scientific instrumentation). However, studies are needed to assess the contribution of such advancements on the role and impact of scientific evidence in criminal case processing. The Forensic Science Service (FSS) research has contributed to forensic science's development and practice. In association with other providers, the FSS has an active multidisciplinary research programme. To be successful and competitive beyond the short term, any provider taking on the current work of the FSS will need to embrace the requirement wholeheartedly within the Framework Agreement for Forensic Providers to carry out relevant research and development. For

new forensic techniques to be fully valid, especially in court, there is a requirement for better communication and scientific and technical performance. This is a productive area where researchers and providers can enhance their research and development work to benefit criminal justice.

Forensic science is the ratifications of the full range of science to questions of interest to a legal system, usually concerning criminal or civil action. It is crucial for the criminal justice system's smooth running, for fighting crime and combating terrorism. Research underpins forensic science's practice to support its development, boost its value to the criminal justice system, and advance the efficiency with which forensic evidence is collected by law enforcement agencies, concocted by forensic service providers, and presented to the courts2. The forensic science providers should have all the active research and development programmes related to their fields of activity, and should typically commensurate with their size. Many universities reported relevant research, which shows a surprising cross-disciplinarily degree when mapped against conventional subject boundaries. Government-related laboratories are actively elaborated, particularly in setting standards and in work relevant to defence and security. (S, Bernard. 2011, p, 4).

The transformation from forensic science research and development (R&D) initiates new crime-solving techniques and increases forensic testing reliability and efficiency. Just as medical research is pivotal for advancing public health, sustained progress in the research underlying forensic science is critical for advancing people safety and the administration of justice. Strengthening science to improve justice is a crucial goal of the National Institute of Justice (NIJ). Besides, NIJ maintains partnerships with the National Science Foundation (NSF) and the National Institute of Standards and Technology (NIST) to promote forensic science innovation. In 2014, NIJ and NSF collectively initiated an Industry/University Cooperative Research Centre to promote collaboration between universities and industry for forensic science R&D and education. Forensic research in the 1980s laid the foundation for advances in the 1990s and early 2000s thereby having a profound influence on crime laboratories. Although scientific advances, particularly the growth of DNA testing, provided more effective tools for analysing evidence and identifying perpetrators, they also dramatically increased lab services demand. By the late 1990s and through the 2000s, demand exceeded the labs' ability to respond promptly and effectively. Today, forensic scientists are under persistent pressure to produce results faster and at lower cost3.

The National Institute of Justice (NIJ) needs to further its aim by sponsoring research that will deliver "objective, independent, evidence- based knowledge and tools to meet the challenges of crime and justice, particularly at the State and local levels3." It has been over 25 years since NIJ sponsored research to assess the use of all types of scientific evidence in the criminal justice system. Lab resources are typically not available to process most crime scenes or analyse most evidence shapes the uses and effects of scientific evidence. In turn, it is a fundamentally critical condition that a social science researcher must confront in developing an appropriate research policy to explore its role and impact.

Since the 1930s, the U.S. police and courts, and various blue-ribbon crime panels have been recommending the extended use of science in resolving criminal cases. In the 1960s, the President's Crime Commission Task Force reports on Police and Science, and Technology (1967) called for greater dependence on physical evidence in investigating and adjudicating crimes. In the 40 plus years since the publication of those reports, there have been significant progresses in the expansion of forensic (crime) laboratories serving the criminal justice system and in the sophistication of scientific techniques applied to examine and decipher physical traces.

Forensic laboratories have increased almost four-fold since the early 1970s. The increasing drug abuse problem in society mandates the chemical identification of controlled substances, thereby exerting stress on the police and courts to increase their dependence on more objective forms of evidence. It also calls for a scientific breakthrough in DNA testing that uniquely determines the source of biological substances and popular culture that has enfolded forensic science through both fictional and factual crime media. In that manner, Scientific and technological advances made possible through robust research support will be essential to ensuring that crime labs keep pace with growing demand. Scientific advances also play an indispensable role in solving crimes.

Forensic Science: Forensic science is the operation of science to criminal and civil laws implemented by legal systems. It is the use of science in the service of the law. The word 'forensic' derives from the Latin term 'forensis', which means 'of or before the forum5. In Roman era, a criminal charge meant presenting the case before a group of public individuals in the forum6.

Both the accused and the plaintiff would give statements to support their arguments. The individual with the best explanation and delivery would determine the outcome of the case. In modern use, the term 'forensic' is a synonym for 'legal' or 'related to courts'. In this sense, forensic science can be termed as 'legal science'. Forensic science is the scientific method of accumulating and deducing facts about the past. This is especially important in law enforcement, where forensics is done concerning criminal or civil law. The capability to examine and spell out criminal justice evidence accurately is central to every democratic country's justice system's effective functioning and credibility. There is a constant need to improve forensic analytic techniques' accuracy and reliability, known as forensic science7. The best method to meet that need is through bringing the full power of scientific research to bear on forensic science questions and methods. Forensic science is an essential element of the criminal justice system. Forensic scientists inspect and analyse evidence from crime scenes and elsewhere to develop objective findings that can assist in investigating and prosecution of perpetrators of crime or absolve an innocent person from suspicion.

All the branches of science such as physics, chemistry, anatomy, physiology, medicine, surgery, chemistry, physics, and botany, lend their aid as necessity arises. In some cases, all these branches are needed for a court of law to reach at a proper judgement on a contested question affecting life or property. In fine, forensics is concerned with recognising, identifying, individualising, and evaluating physical evidence using natural science methods in matters of legal significance8. The outcome of forensic science is forensic evidence. The scientific examinations of forensic scientist adjoin a missing link or strengthen a weakness in the chain of investigations by furnishing impartial and establish

evidence, thereby helping the court conclude the criminals and their punishment. The field of study or examination of a forensic scientist is very vital, divisible and random. Generally, the job of forensic scientists are quite hazardous, onerous and risky because they are to deal with the material exhibits about various nature of crimes such as murder, rape, blood, saliva, firearms, explosives, and explosives substances, liquor, hashish, adulterer petrol, kerosene, diesel, etc., and other chemical vehicles involved in an accident, numerous types of paints. Weapons used in burglary and arson, different types of poisons and poisonous substances, hair, skeletal remains and other plant or animal remnants are other forensic examinations' parameters.

Apart from these, the forensic expert also examines the forged signatures and documents along with the photographic analysis of all material exhibits. (Agrawal, S.G. 2017, pp.136-137).

Forensic evidence generally refers to a piece of evidence obtained by scientific methods or the assistance of technology such as ballistics, blood grouping, DNA fingerprinting, and court use. Forensic evidence can be used to link between seemingly unrelated crimes. For instance, evidence collected by DNA typing can link an offender to several different crimes or crime scenes.

Impact of forensic science in criminal justice

Forensic science plays the most dominant role both in the pre-trial and trial stages of a criminal proceeding. For example, in the case of hurt, rape, death and acid throwing, doctors' chemical examination and report are essential for criminal adjudication. Some criminal cases relating to murder, suicide and rape involve complex medico-legal issues. Forensic science plays a significant role in every tier of investigation, and trial of such cases commenced from the management and investigation of a crime scene to deposition assessment of evidence to courtroom. Criminal affairs come to the motion with the filing of a case followed by investigations, arrest, framing of charge and trial and come to an end with conviction or acquittal where forensic science leads to a breakthrough. However, unlike the other countries, the people involved in the criminal justice system, such as lawyers, investigation officers, and even judges in our country, are hardly skilled enough to utilise forensic science knowledge for justice purposes. This lousy scenario's underlying cause may be due to the existing legal system's shortcomings and the absence of robust infrastructural mechanisms and a skilled workforce. Considering many cases pending before the courts and an abysmal conviction rate, a solid legal and institutional framework ensuring forensic science in the criminal justice system is imperative. It will accelerate the criminal proceedings in Bangladesh that takes a more extended period now, and ultimately the conviction or acquittal rate will augment to a great extent ensuring the people's access to justice.9 A vital issue is the way in which forensic science evidence is presented and used in criminal proceedings. Often, there exists a communication gap (and even a philosophical difference) between scientists and forensic service providers, the ones who develop forensic methods and, judges and juries, who deal with the evidence based on such methods. In principle, the scientific features of forensic evidence should be uncontroversial.

However, in practice, court time and effort is spent disputing what actually scientific issues are. Furthermore, this can be a hindrance to the acceptance, and hence development in the first place, of innovative forensic protocols. Any measures that could be taken to streamline the handling of these issues would be desirable. The Forensic Science Regulator aims to establish an appropriate quality standards regime for forensic science services across the criminal justice system. However, in addition to assuring forensic science's quality, increasing the perception of the techniques used would enhance the use of forensic evidence being brought into court. In all scientific records and areas of application, learned and professional societies and related bodies have a significant role in providing an independent forum for the communication, development and validation of notion. These activities occur in various ways, such as publications and conferences, and within the informal networks that organisations naturally facilitate. Moreover, these societies and bodies play an essential advocacy role for their relevant communities and professions. (S, Bernard. 2011, pp. 10-11).

Powerful and valid forensic science analytic techniques are crucial to a credible, transparent, and evidence-based criminal justice system. There is a rampant consensus that the scientific foundation of some currently available forensic methods needs strengthening, and that external, more efficient techniques are an urgent requirement. This can only be reached through sustained research programs explicitly designed to ensure and improve the reliability and validity of current methods and uphold the development and use of modern techniques. This task is daunting due to the broad nature of the field—forensic science issues range from crime scene investigations to an analysis of various evidence types.

Furthermore, forensic science practice is supported by many different disciplines, including biology, chemistry, statistics, etc. Given the challenges faced by forensic labs in terms of resources, caseloads, and irregularities in configuration among state and local authorities, there is an urgent need for supervision and authority at the national level to devise an extended program of high quality, strategically focused research aimed to enhance the forensic tools available to the criminal judicial system.

The National Institute of Justice (NIJ) of the U.S. Department of Justice (DOJ) acts as the department's research arm for crime and justice issues. This agency supports several research and development programs aimed at advancing knowledge of the crime, crime control, and the implementation of justice and improving activities within the criminal justice system. NIJ has supplicated the National Research Council to appoint a body to examine its recent efforts to strengthen its role as a scientific agency and advance forensic science research. (Support for Forensic Science Research: Improving the Scientific Role of the National Institute of Justice. 2015). Washington, DC: The National Academies Press, pp.1-2).

Researchers analysed the role of forensic evidence in solving five felony crimes (aggravated assault, burglary, homicide, rape and robbery) in five domains. Overall, the conclusions suggested that law enforcement officers decided which forensic evidence from crime scenes would be analysed; this means that officers were exercising prominent discretion in deciding evidence examination priorities and practices10. Without forensic science applications, criminals can never be adjudged unless a witness is present. While investigators and law enforcement agencies are involved in collecting evidence, be it physical or digital, forensic science deals with analysing evidence to establish facts admissible in the court of law. Hence, in a world devoid of

forensic science, murderers, thieves, drug traffickers and rapists would be roaming scot-free.

A forensic scientist's duties and responsibilities in a criminal investigation are pivotal as it involves examination of evidence with due care to make sure it is not tampered with. A diverse team of forensic experts and tools are involved in the investigation of a criminal act. For example, forensic pathologists are skilled at determining the cause of death by conducting autopsies. An autopsy helps determine the cause and manner of death by examining body fluids and tissues. Forensic scientists analyse physical evidence (fingerprints, blood, hair etc.) collected from the crime scene to identify suspects. Forensic professionals also use image modification tools to search for criminals absconding from the law for a long time. This tool facilitates them to digitally age a photograph to understand how the individual would look on ageing11. People confidence in the criminal justice system is pivotal. Maintaining the quality and sustainability of forensic tools is essential to the apprehension, analysis and prosecution of criminal offences and the fair enforcement of justice. Criminal law mainly concerns social protection, prescribes behaviour rules to be observed by all persons, and punishes them for deviance transgression. The law governs social interests, arbitrates conflicting claims and demands.

Security of person and property of the people is an essential function of the State. It could be accomplished through the instrumentality of Criminal law.

There is a cross-cultural conflict where the existing law must answer the new challenge, and the Courts are needed to mould the sentencing system to meet the challenges. The contagion of lawlessness would menace social order and lay it in rubbles. Protection of society and uprooting criminal proclivity must be the object of law which must be achieved by enforcing pertinent sentence. Thus, the law as a cornerstone of the edifice of order should meet the challenges confronting society. (Agarwal, S.G., 2017, p.5).

NIJ should create a critical communication plan that proactively ensures the importance of the agency's investment in research and development on the subject to policymakers and the public by stressing the significance of forensic science research to the legal system and by adopting future projections from new tools and techniques. Implementation of a well-planned communications system will help the agency achieve its goals by encouraging innovative, evidence-based practices by practitioners and more active recruitment of researchers from related disciplines.

The role of research and development in the study of forensic science

The institution of forensic science came into existence in our country in the middle of the twentieth century. Before this, in India, some elementary scientific facilities were available to the police in fingerprint bureaux and scientific sections that provided an examination of firearms, footprints, and questioned documents and photography.

All these facilities were available under State CID set up. There also existed chemical examiner laboratories established under British rule, which primarily took up viscera examination and basic blood tests. Often in important Criminal cases, the services of private experts were requisitioned by the Government12.

In India, the increasing awareness among the police and judiciary of the role science played in the scientific evaluation of material clues led to forensic science laboratories in the states and the Centre. However, the progress was relatively slow, and the facility offered was not comprehensive to cover all aspects of forensic science. There was also no systematic and planned development. (Nabar, B.S., 1988, p.8).

Forensic science is predominantly a broad subject that encompasses several scientific disciplines. This review has consciously taken a broad view of forensic science to understand the scope of research relevant to the field and its location, motivation, funding, and contribution to law enforcement and the criminal justice system. The Association of Chief Police Officers (ACPO) is promoted in carrying out its imperative role by the National Policing Improvement Agency (NPIA). NPIA was established in 2007 to improve public safety by boosting capability of the police service, providing professional expertise to the stakeholders and providing essential national services. NPIA works in coordination with ACPO and its associated domain and can be assigned to deliver protocols to enhance capability and assist front-line delivery. NPIA has worked with ACPO in developing a response to the review of research and development in forensic science, and the response incorporates that NPIA has developed and delivered on behalf of the police service.

The current scenario pertaining to research and development activities in forensic science uncovers a fragmented and murky picture that poses many challenges in the current fiscal environment. They are considerable risks to the reputation of the Government and Criminal Justice System that has been highlighted by recent high profile cases that challenge the efficacy of forensic science. (S, Bernard. 2011). Innovations in forensic science have had a powerful impact on justice and the criminal justice system's effectiveness. Most importantly, the developments of new DNA techniques have transformed crime investigations. To meet future demands and improve productivity, further investments will be required, including technology, people, and capabilities. Forensic science research can encompass many scientific disciplines, making it challenging to identify which scientific research and innovation will potentially apply in the criminal justice system (CJS). The government can reduce risks for investors by identifying priority areas for research, innovation and development. The research requirements vary widely from innovations in operational policing, validation of new and emerging techniques to 'blue sky' research that could have applications in the CJS. A challenge is to ensure the right balance of funding across research, development and innovation13.

Recent technological developments create new avenues to undertake robust scientific measures and studies beyond the controlled laboratory environment. The benefits of a real-time and on-site forensic investigation are manifold and such technology can enormously increase the performance of the criminal justice system. They pose technological challenges as such measurement devices and set-ups are normally operated stand-alone in controlled laboratory environment. Furthermore, instrument maintenance and data processing require skilled professionals. A first step is made through the development of 'point-of-care devices based on standard laboratory instrumentation. Point-of-care, a term that refers to healthcare, in this context, relates to bench top equipment that does not require strict laboratory conditions and can be operated regularly by

trained but not necessarily skilled operators. This typically requires instrument miniaturisation, robust methodology, simplified user interfaces, automation, intrinsic calibration and quality control and integrated data processing and reporting. The final step is deploying fully portable, ideally, hand-held devices connected to the sensor platform and can be used for on-site operation in real-time. The technological challenge to create portable devices with measurement capabilities similar to standard laboratory equipment is gigantic. However, the reward would be equally substantial as this would result in a mobile sensor network capable of retrieving information at any desired location and time14.

The scientific insights and developments described above can be of great value to forensic science, specifically in a high-volume casework setting with limited forensic interpretation. There is a strong intrinsic motivation in the criminal justice system to make forensic information available as rapidly as possible, as this helps solve a crime and make legal proceedings more efficient. To prevent delays that naturally occur when evidence has to be dispatched to and analysed by forensic laboratories, there is an interest in law enforcement conducting forensic analyses in-house and directly at the crime scene. However, the lack of controlled laboratory conditions, rigorous quality control procedures and forensic expert knowledge usually prevent findings from being used as evidence in court. With the results being of a presumptive nature, subsequent analysis at the forensic laboratory often remains necessary. The forensic expert capacity is thus used more effectively, and findings can be fed into the platform, creating a continuous platform and data development cycle. This approach would combine central data gathering allowing forensic intelligence and knowledge management with rapid and efficient decentralised forensic analysis. This unique concept, although technologically challenging, could lead to a step-change in the efficiency and efficacy of the forensic information gathering process. It could also cause a paradigm shift in forensic institutes and forensic experts' role in the criminal justice system: a shift towards a new role for forensic institutes and laboratories as custodians of the forensic platforms and point-of-care and portable equipment and methods. It would also allow forensic institutes to develop powerful forensic intelligence tools to reveal potential case and evidence connections, better understand criminal activities, monitor and optimise policing, improve forensic investigations' efficiency, and assist in crime prevention and disruption. (Kloosterman, Ate., Mapes, Anna., Geradts, Zeno & Eijk, Erwin van. Koper, Carola. *et al*. (2015).

The role of forensic science in research and development has come at an opportune moment in the current environment of austerity and rationalisation of services. The ability to respond in a coordinated manner to issues within the criminal justice system utilising science and innovation is crucial to preventing and detecting criminal activity.

The role of the ACPO is to provide the strategic direction and utilise all available resources, including the NPIA in particular, to provide structure to the process. There are some excellent working practice areas, but there are some significant deficiencies in the current scenario. The forensic R&D landscape lacks co-ordination across academia, industry, policing and indeed the government itself.

The complexity of forensic science, and the variety of interests involved, has led to a very complex landscape of research and development. The future health of the subject and the undoubted energy towards innovation need to be appropriately realised, to ensure the best possible linkages between and within the different parts of the research arena. The user community of forensic science mainly includes the law enforcement agencies and the criminal justice system. Their needs, to stand up in court, are somewhat different from those of most areas of applied science and engineering, which results in unique validation and dissemination requirements. These should be seen as an integral part of research and development.

The validation of forensic techniques is a pre-requisite for the development and introduction of new or improved techniques. In the forensic casework context, the Forensic Science Regulator has outlined both the process and the documentation requirements within its Codes of Practice and Conduct. Within these requirements is the need for a clear understanding and articulation of both the potential and the limitations of any particular method. (S, Bernard. 2011, p.4-8). NIJ seeks to be crucially concerned with building the research infrastructure for forensic science, including broadening the forensic research community and helping the next generation of forensic science researchers. Bolstering the research infrastructure could also include internal efforts, such as building institutional knowledge of emerging, relevant technologies in related fields with forensic uses. Also, NIJ should integrate research and evaluation into all of its forensic science investments. (National Academies of Sciences, Engineering, and Medicine. 2015. Washington, DC, p.65-66). Findings and developments from NIJ-funded studies can and have been used in forensic laboratories' protocols and practices.

One of the hallmarks of other federal research funding agencies' success is stability in their budgets and consistency in the research activities they promote, although specific preferences do vary with circumstances. Steady and foreseeable funding enables agencies to build and sustain a research infrastructure: it motivates talented researchers to pursue scientific careers, keeps established researchers engaged over a career and, attracts and retains talent (National Research Council, 2014, p. 2). Therefore, stable funding, at least at some core level, would be a critical factor for any effective strategy to go forward. NIJ's funds to support research in forensic science should be optimum to enable the agency to strengthen forensic research and practice at the local, state, and federal level; policy makers will need funding stability to assign a dedicated funding body of sufficient magnitude for research activities. This body would have to be adequate, and stable appropriations should be equipped with funding flexibility to help support both short and long term research strategies. The policymaker funding stream for R&D would demonstrate the importance of research to strengthen forensic science and convey policy makers' prioritisation and regularisation of the forensic science field's urgent needs. (Nationademies of Sciences, Engineering, and Medicine. 2015. Washington, DC, p.67-68).

Reliability, validity, and credibility in forensic science are critically dependent on a solid research base. Forensic research is both basic and applied in nature, and it extends from public laboratories to private industry laboratories to academia; almost all of it is funded by the federal government15. An effective criminal justice system depends on a broad range of valid and reliable forensic techniques and tools developed from a solid

scientific evidence base, maintained and advanced by sound and stable programs of basic and applied research. NIJ is the federal agency in charge of bringing the power of scientific research to bear on administering a fair and effective criminal justice system. This purpose guides the agency to support research that will serve the nation's forensic science field, particularly at the state and local levels. Scientific research, development, and evaluation of modern tools and procedures are a prerequisite for the advancement of forensic services and ensuring the administration of justice. Academic researchers who undertake basic and applied forensic research are considered an essential part of the field.

Findings and recommendations

The purpose of this study is to examine its recent efforts to strengthen its role as a science agency and to advance forensic science research. The application of modern science and technology during the past decades, for instance, in microbiology, chemistry and information technology, has already created a considerable growth in demand for forensic science services. If new technology is available to provide valuable information to solve the crime, there will immediately be a strong demand for it.

The establishment and management of a critical plan for the forensic science R&D program with short and long term objectives would help create stability for the research community (and ultimately the practice and policy associated with forensic science) and provide a roadmap for critical advancements while still allowing for creativity and innovation. Federal policymakers should ensure the National Institute of Justice's ability to advance forensic science research and development through dedicated, adequate, and stable appropriations coupled with funding flexibility to help support short- and long-term research strategies. To ensure periodic funding stability, policymakers should designate a dedicated funding stream for research and development that is of sufficient magnitude to address forensic science challenges, making its processes to identify forensic science practitioners' needs more transparent and developing the level of autonomy and independence for its scientific peer-review process. Exploring the size of its research and development portfolio across forensic science disciplines; rising outreach and dissemination to the practice and research communities; bringing new investigators to forensic science research.

Representative organisations and their membership communities should strive to activate voluntary effort (including in leadership roles) to improve the impact and range of their activities such as, to strengthen coordination and create information sources within the field of forensic science.

The National Institute of Justice should develop standards for procedures and metrics to measure outcomes on a regular basis and evaluate the impact of its forensic science research and capacity-building portfolio.

It is recommended that attention should be paid towards the establishment of forensic science as a strategic research priority for the Research Councils.

If these recommendations are fully executed and potential barriers overcome, the committee believes there will be an enormous enhancement in the criminal justice system's ability to collect, catalogue, store, and translate forensic data. As a result, people's confidence in a fair and more credible criminal justice system will be enhanced.

Conclusion

Forensic science encompasses a several scientific disciplines. This review has consciously taken a broad view of forensic science to understand the scope of research appropriate to the field and its location, motivation, funding, and contribution to law enforcement and the criminal justice system. NIJ has on-going investments in fluid dynamics research, intending to provide examiners with objective computational tools to assist in their analyses. Additionally, the bias study results indicate that crime labs and law enforcement agencies should take steps to minimise extraneous information that analysts receive before they conduct an analysis. This paper also examines that NIJ has made some beneficial changes to its process for seeking and awarding conferring grants, thereby improving the agency's scientific capability.

Reliability, validity, and credibility in forensic science are critically dependent on a robust research base. Forensic research has both basic and applied use, and it occurs in public laboratories, private industry laboratories, and academia; almost all of it is funded by the federal government. The need to improve the scientific basis for some forensic disciplines is high quality—forensic science issues range from crime scene investigations to analysis of a variety of types of evidence. Furthermore, many different subjects are informed forensic science practice, including biology, chemistry, statistics, and others. Given the challenges facing forensic science laboratories in terms of resources, caseloads, and variations in configuration among state and local jurisdictions, there is an urgent need for leadership at the national level to frame and sustain an extensive program of high-quality, strategically focused forensic science research established to improve the forensic tools available to the criminal justice system. There is widespread agreement that the scientific foundation of some currently available forensic science methods needs strengthening, and that additional, more efficient techniques are urgently needed. These needs can only be met through sustained research programs explicitly designed to ensure and improve the reliability and validity of current methods and promote the development and use of new and better techniques. Finally, forensic science R&D is conducted to improve public safety and ensure that justice is fairly applied. For NIJ, that means improving the information available to all parties as a crime is investigated and prosecuted. NIJ's investment in research is strengthening science and enhancing justice. It is the Institute's most enduring contribution to forensic science. It should develop a strategic communication plan that proactively promotes the value of the agency's investment in research and development in forensic science to policymakers and the public by emphasising the significance of forensic science research to the criminal justice system and by estimating future savings from the creation and adoption of innovative tools and techniques. Thus, this plan will help the agency advance forensic science in research and development.

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