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Forensic Science in Criminal Investigation: Its Role, Significance, and Impact on the Justice System

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Abstract

Forensic science has emerged as an indispensable component of modern criminal investigation and the administration of justice. Through the systematic application of scientific principles and techniques, forensic experts collect, preserve, and analyse physical evidence in a manner that enables courts to establish facts with a high degree of certainty. This paper examines the evolving role of forensic science in criminal proceedings, its contribution to accurate fact-finding, and its broader impact on the justice system. The study draws on legislative provisions, judicial pronouncements, and scholarly literature to demonstrate that forensic evidence not only strengthens the prosecution's case but also serves as a safeguard against wrongful conviction, thereby reinforcing the foundational principles of fairness and due process.

Keywords: Forensic Science; Criminal Investigation; Forensic Evidence; Administration of Justice; Wrongful Conviction.

Introduction

The detection and investigation of crime has undergone a fundamental transformation with the integration of scientific methods into law enforcement. Forensic science broadly defined as the application of scientific knowledge and methodology to legal questions bridges the gap between laboratory findings and courtroom proceedings. Its disciplines span a wide spectrum, from fingerprint analysis and DNA profiling to digital forensics, toxicology, ballistics, and forensic psychology.

Historically, criminal investigations relied predominantly on witness testimony, confessions, and circumstantial reasoning. While these remain relevant, they are inherently susceptible to human error, bias, and manipulation. The introduction of forensic techniques has provided an objective, evidence-based dimension to the investigative process, enabling investigators to corroborate or refute claims with scientific rigour. In the Indian context, the

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importance of forensic science has been recognised through legislative instruments such as the Indian Evidence Act, 1872 (now the Bharatiya Sakshya Adhiniyam, 2023), the Code of Criminal Procedure, 1973 (now the Bharatiya Nagarik Suraksha Sanhita, 2023), and various Supreme Court directives mandating the use of scientific evidence in serious offences.

Historical Background of Forensic Science

The roots of forensic inquiry can be traced to ancient civilisations. Chinese texts from as early as the 13th century describe rudimentary methods of distinguishing murder from natural death. In India, references in classical legal treatises allude to the examination of physical marks and wounds as part of judicial proceedings. The modern discipline, however, took shape in 19th-century Europe, propelled by advances in chemistry, biology, and physics.

The establishment of dedicated forensic laboratories in the 20th century marked a turning point. India's first forensic science laboratory was set up in Calcutta in 1897, primarily for fingerprint analysis. Over the decades, the Central Forensic Science Laboratory (CFSL) and several state-level laboratories were established, expanding the range of services to include serology, ballistics, document examination, and, eventually, DNA analysis. The evolution from rudimentary fingerprint comparison to sophisticated genomic profiling illustrates the extent to which the field has advanced.

Key Branches of Forensic Science in Criminal Investigation

Forensic science encompasses a number of specialised disciplines, each contributing distinct capabilities to the investigative process. Forensic biology, including DNA profiling, enables the identification of individuals from minute biological samples of blood, saliva, hair, or skin cells. Since the landmark case of State of Andhra Pradesh v. S. Nageshwar Rao (2012), Indian courts have consistently accepted DNA evidence as highly probative, provided that proper chain-of-custody protocols are followed.

Forensic chemistry and toxicology deal with the identification of poisons, drugs, accelerants, and other chemical substances that may be connected to a crime. Ballistics and firearms examination focus on matching bullets, cartridge cases, and weapons to specific incidents. Digital and cyber forensics among the fastest growing branches address evidence extracted from computers, mobile devices, surveillance systems, and online platforms. Document examination, fingerprint analysis, forensic odontology, forensic psychology, and forensic anthropology round out the major sub-disciplines, each playing a role in different categories of criminal cases.

Legal Framework Governing Forensic Evidence in India

Indian law contains several provisions that facilitate the use of forensic evidence. Section 45 of the Indian Evidence Act, 1872 (corresponding to Section 39 of the Bharatiya Sakshya Adhiniyam, 2023) allows courts to receive the opinion of experts in science, art, or any specialised field when the court requires assistance in forming a judgment on technical matters.

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Sections 293 of the Code of Criminal Procedure, 1973 (corresponding to Section 329 of the Bharatiya Nagarik Suraksha Sanhita, 2023) enables reports from government scientific experts including directors of forensic laboratories to be admitted without requiring their physical appearance in court, unless specifically summoned.

The Supreme Court of India has, in a series of judgments, underscored the importance of forensic science. In Selvi v. State of Karnataka (2010), the Court emphasised the need for voluntariness and procedural safeguards in the use of scientific techniques such as narco-analysis, polygraph tests, and brain-electrical oscillation profiling. The Court held that while scientific methods may aid investigation, they must not infringe upon an individual's fundamental rights under Articles 20(3) and 21 of the Constitution. The Malimath Committee Report (2003) also recommended enhanced use of forensic evidence to reduce over-reliance on eyewitness testimony, which is well-documented as a frequent source of miscarriages of justice.

Forensic Evidence and the Strengthening of the Justice System

The integration of forensic science into criminal proceedings serves multiple objectives. First, it enhances the accuracy of fact-finding. Physical evidence when properly collected, preserved, and analysed is generally more reliable than testimonial evidence, which can be influenced by memory distortion, fear, or dishonesty. Forensic evidence can independently corroborate or contradict witness accounts, thereby providing courts with an additional, objective layer of proof.

Second, forensic science acts as a safeguard against wrongful conviction. Innocence projects around the world have demonstrated that DNA testing has exonerated hundreds of individuals who were convicted on the basis of flawed eyewitness identification or coerced confessions. In India, the growing use of DNA profiling has similarly helped in both identifying the guilty and clearing the innocent.

Third, forensic evidence strengthens the investigative capacity of law enforcement agencies. Techniques such as crime scene reconstruction, geographic profiling, and trace evidence analysis enable investigators to develop leads and narrow the pool of suspects with greater precision. This not only improves the efficiency of investigations but also contributes to the deterrence of crime.

Challenges and Limitations

Despite its considerable promise, the use of forensic science in India faces significant challenges. Infrastructure remains a major concern: many state-level forensic laboratories are understaffed, under-equipped, and burdened with substantial backlogs. The National Forensic Sciences University (NFSU), established in 2020, represents an important step toward building capacity, but the gap between demand and supply of trained forensic professionals remains wide.

Quality control and standardisation present additional challenges. Not all forensic laboratories in India adhere to uniform protocols, and the absence of mandatory accreditation has

at times raised questions about the reliability of test results. The risk of evidence contamination at crime scenes often attributable to inadequately trained first responders further undermines the evidentiary value of forensic findings.

The admissibility and weight accorded to forensic evidence also depend on the competence of the expert witness. Courts have occasionally criticised forensic reports that lack methodological rigour or that reflect bias. Ensuring that forensic experts maintain independence and adhere to established scientific standards is essential for sustaining judicial confidence in their findings.

Conclusion

Forensic science has fundamentally reshaped the landscape of criminal investigation and the administration of justice. Its capacity to generate objective, reproducible evidence provides a critical complement to traditional investigative methods and serves as a powerful check on the inherent limitations of witness testimony. In the Indian context, legislative reforms, judicial directives, and institutional developments such as the establishment of the NFSU signal a growing recognition of the discipline's importance.

However, the full potential of forensic science can be realised only if systemic challenges including infrastructure deficits, staffing shortages, quality-control gaps, and the need for standardised protocols are addressed through sustained policy attention and investment. A well-functioning forensic infrastructure not only aids in the conviction of the guilty and the exoneration of the innocent but also reinforces public confidence in the fairness and integrity of the justice system as a whole.

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