

A CRITICAL ANALYSIS OF FORENSIC EVIDENCE AND WRONGFUL CONVICTIONS IN INDIA

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ABSTRACT

The integrity of forensic evidence is foundational to the legitimacy of criminal justice. In India, however, systemic deficiencies in forensic infrastructure – including chronic laboratory understaffing, inadequate funding, the absence of uniform protocols, and a structural conflict of interest arising from the institutional proximity of forensic laboratories to law enforcement agencies – have rendered forensic evidence unreliable in a significant proportion of criminal trials. This article undertakes a comprehensive critical analysis of the role of forensic evidence in wrongful convictions in India. It examines the conceptual and legal framework governing forensic evidence under the Indian Evidence Act 1872, the evidentiary value and limitations of major forensic disciplines (DNA profiling, fingerprint analysis, ballistics, and toxicology), the institutional architecture of forensic science in India, and the primary causes of wrongful convictions. The article draws on comparative analysis of the Daubert standard (United States), the Forensic Science Regulator model (United Kingdom), and the accreditation frameworks of Australia to identify lessons applicable to India. It concludes with concrete legislative, institutional, and capacity-building recommendations – including the establishment of an independent National Forensic Science Commission, amendment of Section 45 of the Indian Evidence Act to incorporate reliability criteria, and urgent enactment of the DNA Technology (Use and Application) Regulation Bill – to strengthen forensic science and reduce the incidence of wrongful convictions in India.

Keywords: forensic evidence, wrongful convictions, Indian Evidence Act, DNA profiling, cognitive bias, Daubert standard, forensic reform, Section 45, NFSC, criminal justice India

I. INTRODUCTION

A wrongful conviction – the conviction of an innocent person for a crime committed by another – represents the most catastrophic failure of a criminal justice system. Its consequences extend far beyond the individual convicted: the true perpetrator escapes accountability, victims are denied justice, and public confidence in the rule of law is irreparably eroded. In India, the problem of wrongful convictions is compounded by the state of the forensic science system upon which

criminal trials increasingly depend. Science, widely perceived as objective and infallible, can be deeply flawed in practice: in the laboratory, in the crime scene, in the courtroom, and in the minds of the analysts who interpret its results.

India's forensic science system was established during the colonial era with the founding of the Calcutta Fingerprint Bureau in 1897 and the first forensic laboratory in 1952.¹ Seven decades later, the system remains burdened by chronic resource deficits, an outdated evidentiary framework rooted in the

Indian Evidence Act of 1872, and an absence of independent regulatory oversight. The Innocence Project's research in the United States has demonstrated that flawed forensic science was a contributing factor in approximately 45% of DNA exoneration cases.² There is no comparable national database of wrongful convictions in India, but the available evidence from courts, media investigations, and civil liberties organisations suggests that the problem is substantial and systemic.

This article addresses that systemic problem. Section II examines the legal and conceptual framework governing forensic evidence in India. Section III analyses the evidentiary value and limitations of the principal forensic disciplines. Section IV surveys India's institutional architecture for forensic science. Section V analyses the primary causes of wrongful convictions, with particular attention to forensic evidence failures. Section VI draws comparative lessons from international jurisdictions. Section VII presents findings and reform recommendations.

II. LEGAL AND CONCEPTUAL FRAMEWORK OF FORENSIC EVIDENCE IN INDIA

A. The Indian Evidence Act and Expert Opinion

The admission of forensic evidence in Indian courts is primarily governed by the Indian Evidence Act 1872 (IEA). Section 45 of the IEA provides that the opinions of persons 'specially skilled' in science, art, handwriting, or finger impressions are relevant facts, admitting them as expert opinion evidence. The section establishes a low threshold for admissibility: it requires only that the witness possess superior skill or knowledge in the relevant area, without requiring the court to scrutinise the scientific reliability or methodological soundness of the expert's opinion before admission.³

This stands in sharp contrast to the Daubert standard applied in the United States, where trial judges are required to act as 'gatekeepers' evaluating the reliability of expert testimony before admission by reference to

criteria including testability, peer review, known error rates, and general acceptance in the scientific community.⁴ The absence of any equivalent reliability criterion in Section 45 means that flawed, outdated, or scientifically unsupported forensic testimony can enter the Indian courtroom unfiltered – a critical structural vulnerability in India's criminal justice architecture.

B. Classification of Forensic Evidence

Forensic evidence in India may be classified into five principal categories. Biological evidence encompasses DNA, body fluids, hair, and skin cells – with DNA profiling representing the most powerful individualization tool currently available. Physical evidence includes fingerprints, footwear impressions, and tool marks. Chemical evidence encompasses drugs, poisons, explosives, and agricultural chemicals analysed through toxicological methods. Ballistic evidence involves the examination of firearms, ammunition, and gunshot residues. Documentary evidence covers handwriting, questioned documents, and signatures. A sixth and rapidly growing category – digital evidence – encompasses data from electronic devices and communication networks, governed in India by the Indian Evidence (Amendment) Act 2000 and the Information Technology Act 2000.

Central to all forensic disciplines is the principle of individualisation – the linking of physical evidence to a single specific source. This principle has come under increasing scholarly scrutiny: the National Research Council's landmark 2009 report found that the foundational claim of fingerprint uniqueness has never been subjected to adequate large-scale empirical testing, and that tool mark comparisons may be confounded by manufacturing similarities across production runs.⁵ These challenges have profound implications for the reliability of forensic evidence and, by extension, the safety of convictions founded upon it.

III. EVIDENTIARY VALUE AND LIMITATIONS OF KEY FORENSIC DISCIPLINES

A. DNA Profiling

Developed by Sir Alec Jeffreys in 1984, DNA profiling has become the gold standard in forensic identification. The probability of a coincidental match between unrelated individuals in a complete DNA profile is estimated at less than one in several billion, giving DNA evidence an exceptionally high discriminative power. In India, DNA profiling is primarily deployed in cases of homicide, sexual assault, and violent offences, with the Central Forensic Science Laboratory (CFSL) and several State Forensic Science Laboratories (SFSLs) equipped to perform such analyses.⁶

Despite its scientific power, the evidentiary value of DNA profiling depends entirely on the integrity of the sample throughout the evidence chain. In India, contamination and degradation risks are elevated by the subtropical climate, the absence of standardised evidence collection protocols, inadequate preservation facilities, and insufficient training of first responders. A particularly under-recognised risk is secondary DNA transfer – the inadvertent movement of DNA from one surface to another through an intermediary – which can place an innocent person's genetic material at a crime scene they never physically entered. Failure by forensic analysts and courts to account for secondary transfer has demonstrably contributed to wrongful identifications in documented international cases.

B. Fingerprint Analysis

Fingerprint analysis is among the oldest and most widely used forensic identification techniques in India. Governed by the principle that friction ridge patterns are permanent and unique, fingerprint evidence is admissible under Section 45 of the IEA as expert opinion regarding finger impressions. The National Crime Records Bureau operates the Central Fingerprint Bureau,

which maintains India's national fingerprint database.⁷

However, the NRC's 2009 report expressly found that the claim of fingerprint uniqueness has not been validated by large-scale empirical research, and that the visual comparison of latent prints involves substantial subjective judgment. Studies have documented significant variability in conclusions reached by different examiners reviewing the same prints. In India, these scientific concerns are compounded by poor evidence collection practices at crime scenes, inadequate storage, and the absence of quality assurance systems in most fingerprint bureaux – rendering fingerprint evidence particularly susceptible to error.

C. Ballistics and Toxicology

Forensic ballistics – the examination of firearms, bullets, cartridge cases, and gunshot residues – is performed by CFSLs and SFSLs using visual and microscopic comparison techniques including the comparison microscope. The scientific validity of firearms identification has been questioned by researchers who note that, unlike DNA profiling (which rests on well-established genetic probability calculations), firearms identification relies on the subjective visual comparison of microscopic striations, with documented variability in accuracy depending on the examiner's skill and experience.⁸

Forensic toxicology – the analysis of biological samples to identify and quantify drugs, poisons, and toxic substances – plays a particularly important role in India given the high incidence of agricultural chemical poisoning cases. Toxicological analyses are conducted using gas chromatography, liquid chromatography, mass spectrometry, and immunoassay techniques. Each method carries specific sensitivity thresholds and limitations, and the integrity of toxicological evidence is critically dependent on the timely and proper collection and preservation of biological

samples – areas where significant practice gaps have been documented.

IV. INSTITUTIONAL FRAMEWORK FOR FORENSIC SCIENCE IN INDIA

A. Central and State Forensic Science Laboratories

India's forensic science infrastructure comprises Central Forensic Science Laboratories (CFSLs) under the Ministry of Home Affairs – located in New Delhi, Hyderabad, Chandigarh, and Kolkata – and State Forensic Science Laboratories (SFSs) maintained by each state's Home Department. The CFSLs provide services in biology, chemistry, physics, ballistics, toxicology, questioned documents, and DNA profiling to central and state law enforcement agencies and the judiciary.⁹

The system suffers from chronic and severe resource deficiencies. CFSLs operate with only a fraction of their sanctioned workforce due to budgetary constraints, bureaucratic delays in recruitment, and a shortage of qualified forensic scientists – creating extensive case backlogs that can delay criminal investigations and prosecutions by months or years. The situation varies dramatically across states: well-resourced states such as Maharashtra, Gujarat, Karnataka, and Tamil Nadu maintain comparatively capable laboratories, while smaller or economically constrained states operate with minimal infrastructure. This geographic inequity in forensic capability means that the reliability of evidence available in a criminal trial depends, in large measure, on where the offence was committed – a constitutionally troubling outcome.

B. Structural Conflict of Interest

A structural deficiency of particular constitutional concern is the administrative location of SFSs within state Home Departments – the same departments that control the police forces whose investigations the laboratories are called upon to evaluate. This institutional proximity creates an inherent

conflict of interest that compromises the independence and objectivity of forensic analysis. When forensic scientists are civil servants employed by the same administrative authority as investigating officers, the conditions are created for the cognitive biases identified in forensic psychology – confirmation bias, expectancy effects, anchoring, and contextual bias – to operate without adequate institutional checks. Research has shown that forensic analysts provided with information about an investigating team's preferred suspect are measurably more likely to interpret ambiguous evidence in a manner that supports that theory of the case.¹⁰

C. The National Forensic Sciences University

The National Forensic Sciences University (NFSU), established by statute in 2020, represents a significant institutional development – the first university in India dedicated exclusively to forensic science education and research. The NFSU offers undergraduate, postgraduate, and doctoral programmes, provides training for law enforcement personnel and judicial officers, and has begun developing standardised protocols for forensic analyses.¹¹ However, as an institution in its early years, the NFSU faces challenges in attracting and retaining high-quality faculty given comparatively lower public sector salaries, and its geographic footprint does not yet adequately serve all regions of India.

V. WRONGFUL CONVICTIONS: CAUSES AND CONTRIBUTING FACTORS

A. Eyewitness Misidentification

Eyewitness misidentification is the leading cause of wrongful convictions globally, accounting for approximately 70% of DNA exoneration cases documented by the Innocence Project.¹² Cognitive psychology research has established that human memory is not a precise record of past events but a reconstructive process susceptible to distortion by stress, poor viewing conditions, weapon

focus, cross-racial identification difficulties, and suggestive identification procedures. In India, eyewitness identification parades are routinely conducted in conditions that fall short of the standards prescribed by Supreme Court guidance in cases such as *State of Uttar Pradesh v. Naresh and Ors.*¹³ – with investigative officers frequently conducting identifications in suggestive circumstances that inflate the risk of misidentification.

B. False and Coerced Confessions

False confessions – a principal contributor to wrongful convictions in documented cases worldwide – are produced through psychological pressure during custodial interrogation, deceptive interrogation techniques, and the particular vulnerability of juveniles, intellectually disabled persons, and mentally ill suspects. Although Section 25 of the Code of Criminal Procedure 1973 prohibits the admission of confessions made to police officers, and Section 164 requires magistrates to verify voluntariness, these protections are frequently circumvented in practice through prolonged detention, physical coercion, and inadequate magisterial scrutiny. India's failure to mandate electronic recording of custodial interrogations – a reform that has dramatically reduced false confessions in jurisdictions that have adopted it – perpetuates an environment in which coerced confessions can be obtained and admitted without contemporaneous record.¹⁴

C. Forensic Evidence Failures

The Innocence Project's analysis found that flawed forensic science contributed to approximately 45% of all DNA exonerations in the United States.¹⁵ The categories of forensic failure identified include: use of invalid or unvalidated forensic methods; improper collection or handling of evidence; sample contamination or degradation; misinterpretation of laboratory results; misleading or overstated expert testimony; and deliberate fabrication of forensic evidence. Each of these failure modes is present in the Indian

forensic science context, exacerbated by the systemic deficiencies in infrastructure, training, quality assurance, and institutional independence documented in Section IV above.

Cognitive bias represents a particularly insidious and under-addressed source of forensic error. Confirmation bias – the tendency to interpret ambiguous evidence in ways that confirm pre-existing hypotheses – has been empirically demonstrated in studies of DNA mixture interpretation, fingerprint comparison, and firearms identification. When Indian forensic scientists operate under institutional pressure from law enforcement agencies within whose administrative structure they are embedded, and when they receive contextual information about the investigating officer's preferred suspect, the conditions for confirmation bias are maximised. India's legal framework currently contains no mechanism to detect or mitigate cognitive bias in forensic analysis.

VI. COMPARATIVE ANALYSIS: INTERNATIONAL BEST PRACTICES

A. The United States: Daubert Judicial Gatekeeping

The United States Supreme Court's decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.* (1993) established the most influential standard for the admissibility of expert scientific testimony.¹⁶ Under *Daubert*, trial judges are required to act as gatekeepers, evaluating expert testimony for relevance and reliability before admission. The factors for reliability assessment include: whether the theory or technique can be and has been tested; whether it has been subjected to peer review and publication; its known or potential error rate; the existence of controlling standards; and its general acceptance within the relevant scientific community. The *Daubert* standard has led to the exclusion of several historically accepted forensic disciplines – including bite mark analysis, hair microscopy, and certain firearms identification claims – that cannot satisfy reliability scrutiny.

B. The United Kingdom: Independent Regulatory Oversight

The United Kingdom established the office of Forensic Science Regulator (FSR) to ensure the quality of forensic science services provided across the criminal justice system. The FSR sets quality standards for forensic laboratories, monitors compliance, investigates complaints about service quality, and issues codes of practice covering all aspects of forensic analysis from evidence collection through laboratory analysis to court reporting. The UK model is particularly instructive for India given the shared common law heritage of both systems and the similar structural challenges each has faced. The FSR's experience demonstrates that an independent statutory regulatory body – insulated from law enforcement and prosecutorial influence – can maintain consistent quality standards across a fragmented forensic services landscape.¹⁷

C. Australia: Accreditation and Individual Certification

Australia employs a multi-layered regulatory approach combining statutory accreditation through NATA (using ISO/IEC 17025 standards) with professional frameworks developed by bodies such as ANZPAA and individual certification programs administered through the National Institute of Forensic Science. Australia's model illustrates the importance of certifying individual forensic practitioners – not merely accrediting laboratories – to ensure reliable forensic services. A certified practitioner brings personal accountability to their work that institutional accreditation alone cannot provide.¹⁸

VII. FINDINGS AND RECOMMENDATIONS

A. Major Findings

This research establishes the following principal conclusions:

- India's forensic science system suffers from chronic shortages of trained personnel, inadequate funding, aging equipment, and the absence of effective

quality assurance mechanisms – systemic deficiencies that undermine the reliability and integrity of forensic evidence presented in criminal trials.

- Section 45 of the Indian Evidence Act 1872, rooted in the colonial era, provides an inadequate framework for the admission of expert forensic testimony. Its failure to require reliability scrutiny before admission allows scientifically unsupported or methodologically flawed expert evidence to enter criminal proceedings unchallenged.
- The institutional location of State Forensic Science Laboratories within state Home Departments – the same administrative authority that controls investigating police forces – creates a structural conflict of interest that compromises the independence and objectivity of forensic analysis, creating conditions in which cognitive biases including confirmation bias can operate without institutional checks.
- The principal causes of wrongful convictions in India – eyewitness misidentification, false and coerced confessions, and forensic evidence failures – are exacerbated by the absence of mandatory electronic recording of custodial interrogations, inadequate regulation of identification parades, and the low admissibility threshold for expert testimony.
- India lacks a national database of wrongful convictions comparable to the United States' National Registry of Exonerations, making it impossible to quantify the scale of the problem and identify systemic patterns for reform – an institutional gap that itself requires urgent remedy.

B. Recommendations

On the basis of the foregoing analysis, the following reforms are recommended to

legislators, judicial authorities, and the forensic science community:

- Establish an independent National Forensic Science Commission (NFSC) by statute, accountable to Parliament rather than the Home Ministry, with powers to set national standards for forensic laboratories; accredit laboratories and certify individual forensic practitioners; investigate complaints regarding forensic service quality; conduct periodic audits; and promote research and innovation in forensic science. All forensic laboratories should be transferred to the jurisdiction of the NFSC to eliminate the structural conflict of interest arising from their current administrative location.
- Amend Section 45 of the Indian Evidence Act 1872 to incorporate reliability criteria for the admission of expert forensic testimony, modelled on the Daubert standard and the UK Law Commission's reliability recommendations. Courts should be required to evaluate whether the expert's technique has been tested, peer reviewed, has a known error rate, operates under controlling standards, and has gained general acceptance in the relevant scientific community before admitting expert testimony.
- Enact the DNA Technology (Use and Application) Regulation Bill as a matter of legislative urgency. The legislation should establish a National DNA Data Bank; provide for the mandatory accreditation and licensing of laboratories performing DNA analyses; and ensure robust regulation of the collection, analysis, storage, and sharing of DNA evidence with appropriate privacy protections for accused persons and data subjects.
- Mandate electronic recording of all custodial interrogations, making recorded confessions a prerequisite for their admissibility as evidence. This reform, adopted successfully in multiple common law jurisdictions, is the single most effective safeguard against false and coerced confessions.
- Develop and implement mandatory national standards for eyewitness identification procedures, including double-blind lineup administration, standardised instructions to witnesses, and sequential rather than simultaneous presentation – implementing the best practices endorsed by the Supreme Court in *State of Uttar Pradesh v. Naresh and Ors.* as legally binding procedural requirements.
- Establish mandatory accreditation for all forensic laboratories under ISO/IEC 17025 standards through the National Accreditation Board for Testing and Calibration Laboratories (NABL) or the proposed NFSC, with mandatory proficiency testing for all forensic examiners and the implementation of blind verification procedures.
- Implement mandatory forensic science training modules in judicial education programmes through the National Judicial Academy, and in legal education curricula and continuing legal education programmes, to equip judges and advocates to critically evaluate forensic evidence and identify its limitations.
- Establish a National Registry of Wrongful Convictions, administered by the National Human Rights Commission or the proposed NFSC, to document and analyse exoneration cases and identify systemic patterns driving forensic failure and miscarriages of justice.

VIII. CONCLUSION

Forensic science sits at the intersection of scientific inquiry and the administration of justice. When it functions well – grounded in

validated methodology, conducted by well-trained and institutionally independent scientists, and scrutinised by courts equipped to evaluate its claims – it is a powerful instrument in the service of truth. When it fails – through contamination, cognitive bias, institutional pressure, methodological invalidity, or judicial deference to unscrutinised expert opinion – it becomes an instrument of injustice, capable of sending innocent people to prison and allowing guilty ones to go free.

India's forensic science system, as this research has demonstrated, exhibits systemic failures across each of these dimensions. The remedies are available: the comparative experience of the United States, the United Kingdom, and Australia provides clear models for judicial gatekeeping, independent regulatory oversight, and individual practitioner certification. The legislative building blocks – an amendment to Section 45 of the IEA, the enactment of the DNA Technology Regulation Bill, and the statutory creation of a National Forensic Science Commission – are well within reach.

The cost of inaction is measured in innocent lives destroyed and guilty persons at liberty. India's criminal justice system, and the constitutional guarantee of the right to a fair trial embedded in Article 21 of the Constitution, demand urgent and comprehensive forensic science reform. The research and recommendations presented in this article provide a foundation for that reform agenda.

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