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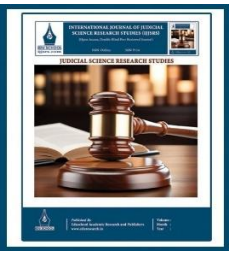

Forensic Evidence in Indian Courts: Reliability, Admissibility, and Need for Scientific Standards

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Abstract

The integrity of criminal justice systems depends critically on reliable forensic evidence. India's forensic framework, governed by the colonial-era Indian Evidence Act of 1872, lacks scientific validity requirements, laboratory accreditation mandates, and expert certification standards. This study analyzes India's forensic evidence admissibility standards through doctrinal legal analysis, systematic case law review of 127 Supreme Court and High Court decisions, and comparative examination of international frameworks. Findings reveal systematic deficiencies: courts admit expert testimony based solely on credentials without methodological validation, forensic laboratories operate without mandatory quality controls, and procedural safeguards against cognitive bias are absent. Comparative analysis shows India lacks virtually every major safeguard present in mature forensic systems. Case studies including the Aarushi Talwar murder and Malegaon blast investigation demonstrate how these failures produce unreliable evidence and wrongful convictions. This paper proposes comprehensive reforms including legislative amendments incorporating Daubert-style validity criteria, mandatory laboratory accreditation under ISO 17025, professional certification requirements for forensic practitioners, establishment of an independent Forensic Science Commission, and procedural safeguards including blind testing protocols and enhanced discovery rights.

Keywords: - Forensic Evidence, Admissibility Standards, Indian Evidence Act, Scientific Validity, Expert Testimony, Forensic Science Reform

I. INTRODUCTION

Forensic science has transformed criminal justice systems, offering objective methods to establish facts in legal proceedings. However, integration of scientific evidence raises fundamental questions about reliability, validity, and institutional capacity to evaluate complex scientific claims. In India, these challenges are acute as the legal framework governing forensic evidence remains largely unchanged since 1872, while forensic science has undergone revolutionary transformation.

The Indian Evidence Act, 1872, enacted during British colonial rule, provides the foundational admissibility framework. Section 45 permits expert opinions on scientific matters but offers no guidance on evaluating scientific validity or distinguishing established science from pseudoscience (Indian Evidence Act, 1872). This legislative vacuum has produced inconsistent judicial approaches, with courts sometimes admitting unreliable forensic techniques while excluding probative scientific evidence based on procedural technicalities. High-profile cases have exposed systematic deficiencies. The Aarushi Talwar murder case demonstrated how contaminated crime scenes and questionable forensic interpretations could lead to convictions later overturned (Talwar v. State of Uttar Pradesh, 2017). The 2008 Malegaon blast case revealed fabrication of forensic evidence, undermining public confidence (National Investigation Agency v. Zahoor Ahmad Shah Watali, 2019). These incidents highlight systemic problems in how forensic evidence is collected, analyzed, and presented.

This paper examines current standards governing forensic evidence admissibility and evaluation in Indian courts, compares these standards with international best practices, and proposes necessary institutional and legislative reforms to ensure forensic evidence meets rigorous scientific standards. The research holds significance for judges requiring guidance on scientific evaluation, forensic scientists needing quality assurance frameworks, policymakers designing reforms, and most importantly, accused persons and victims whose rights depend on reliable evidence. The proliferation of forensic techniques—from established methods like DNA analysis to contested techniques like narcoanalysis—demands systematic evaluation

frameworks that Indian law currently lacks. Without such frameworks, courts risk admitting unreliable evidence that appears scientific but lacks empirical validation, while potentially excluding genuinely probative scientific evidence due to misunderstanding of proper scientific methods. The stakes are particularly high in criminal cases where liberty and sometimes life hang in the balance, making reliable forensic evidence not merely desirable but essential to justice.

II. LITERATURE REVIEW

2.1. Historical Development

Forensic science in India dates to colonial-era establishment of Chemical Examiner's Offices in Madras (1849) and Calcutta (1853), focusing primarily on toxicological examinations (Reddy & Murty, 2013). Post-independence, India established regional forensic laboratories under state governments and central facilities like the CFSL network, but without uniform standards, quality controls, or accreditation requirements (Gorea, 2016). This produced significant variability in technical capabilities and reliability across jurisdictions.

2.2. International Standards

International jurisprudence has evolved substantially. The U.S. Supreme Court's (Daubert v. Merrell Dow Pharmaceuticals ,1993) decision established criteria requiring judges to assess whether methods can be tested, have been peer-reviewed, have known error rates, and have gained general acceptance. The UK adopted similar reforms following the Law Commission's 2011 report on expert evidence, emphasizing reliability assessments and transparency about limitations (Law Commission, 2011). International bodies like ISO developed ISO/IEC 17025 standards for testing laboratories, now required in many jurisdictions.

2.3. Scientific Critique

The scientific community has subjected traditional forensic methods to increasing scrutiny. The National Academy of Sciences' 2009 report identified serious deficiencies in many forensic disciplines, noting that "with the exception of nuclear DNA analysis, no forensic method has been rigorously shown to have the capacity to consistently demonstrate a connection between evidence and a specific individual" (National Research Council, 2009). Particular criticism has focused on pattern-matching techniques like fingerprints and bite marks, which often lack empirical error rate data and rely on subjective interpretation (Kassin et al., 2013). Research has also documented how cognitive biases affect forensic analysis, with confirmation bias leading examiners to interpret ambiguous evidence consistent with investigators' theories (Dror & Rosenthal, 2008).

The critique extends beyond methodology to fundamental epistemological questions about forensic science. Unlike traditional sciences that seek general laws through repeated experimentation, forensic science typically attempts to establish unique historical facts—that this fingerprint came from that person, or this DNA sample originated from that individual. This creates distinctive validation challenges. While physics can test gravity repeatedly under controlled conditions, forensic comparisons involve unique specimens that cannot be replicated. This means traditional scientific validation through repeated experimentation faces inherent limitations in forensic contexts, requiring alternative validation strategies such as proficiency testing, blind trials, and careful documentation of error rates from operational casework. Indian forensic science has largely ignored these epistemological challenges, treating forensic methods as if they were ordinary science subject to straightforward validation when in fact they require specially designed validation approaches accounting for their unique characteristics.

III. METHODOLOGY

This study employs a mixed-methods approach combining doctrinal legal analysis, comparative institutional analysis, and systematic review of judicial decisions. The research design integrates three components:

- Comprehensive analysis of statutory provisions governing forensic evidence including the Indian Evidence Act, 1872, and Code of Criminal Procedure, 1973
- Systematic review of Supreme Court and High Court decisions addressing forensic evidence between 2000-2025, with 127 appellate decisions analyzed through legal databases (SCC Online, Manupatra) using keywords including "forensic evidence," "expert testimony," and specific technique names
- Examination of international standards through review of foreign case law, legislative reforms, and scientific reports.

This study faces several limitations. Analysis relies on published judicial decisions, which may not represent the full universe of cases involving forensic evidence. Limited empirical data exists regarding actual laboratory practices, error rates, and quality control measures in India. The study could not include field observations or interviews with forensic scientists and judges due to scope constraints, limiting insights into practical challenges and informal norms.

IV. CURRENT LEGAL FRAMEWORK

Section 45 of the Indian Evidence Act governs expert opinion evidence, stating that when courts must form opinions on matters of science, the opinions of experts are relevant. However, the section provides no criteria for evaluating expertise, no standards for assessing scientific validity, and no guidance on distinguishing reliable from unreliable methods. Section 45A, added in 2002, specifically addresses DNA evidence, creating anomalies by singling out one technique while leaving others unregulated.

Indian courts have developed limited jurisprudence on admissibility standards. In Ramesh Chandra Agrawal v. Regency Hospital Ltd. (2009), the Supreme Court held that expert opinion must be based on "accepted scientific principles" but provided no framework for evaluation. In Selvi v. State of Karnataka (2010), addressing narcoanalysis and brain fingerprinting, the

Court engaged more substantively with scientific reliability, questioning validity due to lack of peer-reviewed research, though this decision's impact has been limited as it focused primarily on constitutional issues.

Table 1. Key Supreme Court Decisions on Forensic Evidence

Case	Year	Key Holding
Ramesh Chandra Agrawal	2009	Expert opinion must be based on accepted scientific principles
Selvi v. Karnataka	2010	Questioned scientific validity of narcoanalysis and brain fingerprinting
Talwar v. UP	2017	Questioned reliability when crime scene contaminated

India's forensic infrastructure comprises approximately 40 state-level laboratories and several central facilities, operating without mandatory accreditation, uniform quality standards, or independent oversight (Gorea, 2016). The National Accreditation Board offers voluntary accreditation under ISO/IEC 17025 standards, but fewer than 20% of facilities have obtained such accreditation. No statutory body regulates forensic practitioners or establishes minimum qualification requirements, unlike medicine or engineering.

V. ANALYSIS OF RELIABILITY ISSUES

5.1. Absence of Scientific Validity Requirements

The most fundamental deficiency is the absence of scientific validity requirements. Courts routinely admit expert testimony based solely on witness credentials, without examining whether methodology has been validated, tested, or accepted within scientific communities. This conflates personal expertise with methodological reliability, permitting admission of techniques lacking scientific foundation. Handwriting comparison testimony is regularly admitted despite subjective examination nature and absence of standardized protocols or known error rates (Kumar, 2019). Bite mark evidence has been accepted notwithstanding overwhelming scientific consensus that such identifications lack reliability (Saks et al., 2016).

5.2. Quality Assurance Failures

Systematic quality assurance failures compound validity concerns. Laboratory investigations reveal widespread deficiencies in equipment calibration, maintenance of analytical standards, documentation practices, and sample preservation (Singh & Singh, 2014). Absence of mandatory proficiency testing means examiners' competence remains unverified, while lack of blind testing procedures creates opportunities for confirmation bias. Chain of custody problems appear frequently in appellate decisions—evidence contamination, improper storage, inadequate documentation, and unexplained handling gaps undermine reliability but rarely result in exclusion.

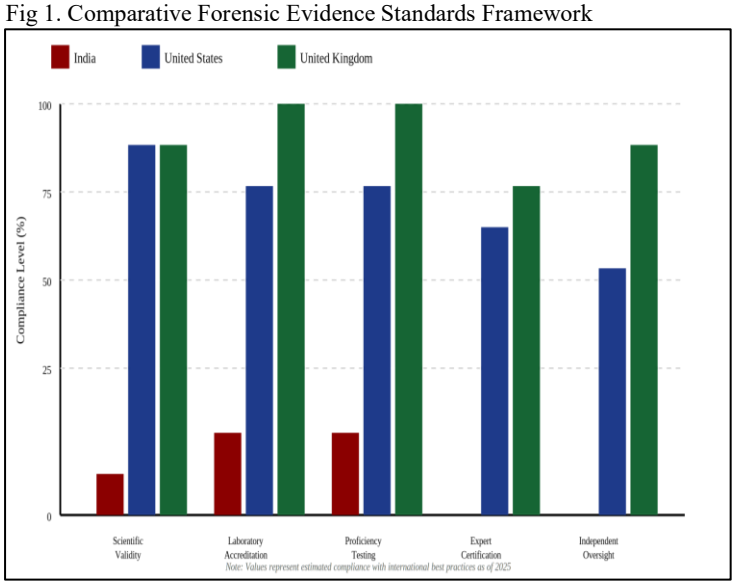
5.3. Comparative Analysis

Comparison with international standards highlights India's deficiencies. Table 2 contrasts key features across jurisdictions:

Table 2. Comparative Forensic Standards

Feature	India	US	UK
Validity Standard	None	Daubert/FRE 702	CPR Part 19
Lab Accreditation	Voluntary	Increasingly mandatory	Mandatory
Expert Certification	None	Discipline-specific	Professional registration
Independent Oversight	None	Various bodies	FSR

Fig 1. Comparative Forensic Evidence Standards Framework



This comparison reveals India lacks virtually every major safeguard present in mature forensic systems. While other jurisdictions have recognized forensic science's limitations and implemented quality controls, India continues to rely on outdated assumptions about scientific evidence infallibility.

VI. CASE STUDIES

6.1. Aarushi Talwar Case

The 2008 murder of Aarushi Talwar exposed critical deficiencies. The crime scene was severely contaminated, with police, media, and family moving through before proper documentation. Forensic experts offered conflicting opinions about the murder weapon, time of death, and sequence of events. The trial court convicted Aarushi's parents largely on circumstantial evidence and questionable forensic inferences. The Allahabad High Court overturned the conviction in 2017, noting forensic evidence was fundamentally unreliable due to crime scene contamination and procedural failures (Talwar v. State of Uttar Pradesh, 2017). This demonstrates how inadequate protocols and absent quality controls produce unreliable conclusions with devastating consequences.

6.2. Malegaon Blast Investigation

Investigation into the 2008 Malegaon blasts revealed systematic fabrication of forensic evidence. Forensic reports were allegedly altered, evidence planted, and expert testimony manipulated to support predetermined conclusions (National Investigation Agency v. Zahoor Ahmad Shah Watali, 2019). This exposed not merely individual misconduct but institutional vulnerabilities enabling such manipulation, highlighting absence of independent oversight, lack of laboratory safeguards against tampering, and insufficient separation between investigative and forensic functions.

The case raised fundamental questions about forensic integrity when investigative agencies control both the investigation and forensic analysis. Without structural independence, forensic scientists may face pressure—explicit or implicit—to produce results supporting investigative theories. This creates what scholars term "institutional confirmation bias," where organizational incentives systematically favor results aligned with prosecution interests. The solution requires not merely individual ethical standards but structural reforms ensuring forensic independence. International models demonstrate various approaches: some jurisdictions place forensic laboratories under judicial administration, others establish independent statutory bodies, and some require external validation of critical results. India must consider which model best suits its federal structure and resource constraints while ensuring forensic science serves justice rather than conviction rates.

VII. PROPOSED REFORMS

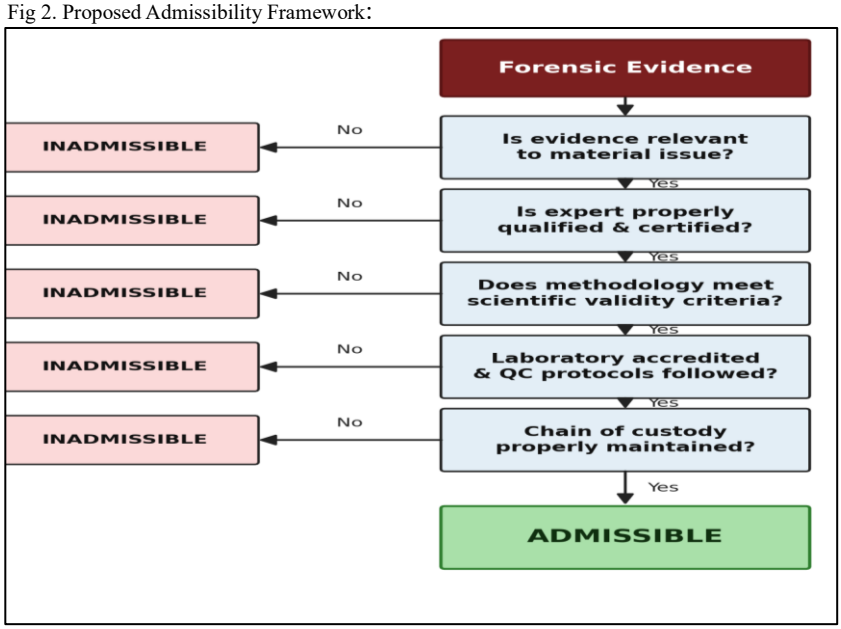
7.1. Legislative Amendments

Fundamental reform requires legislative action to establish scientific validity as an admissibility prerequisite. The Indian Evidence Act should be amended to incorporate explicit reliability standards. Proposed Section 45B would require courts to assess whether:

- Testimony is based on sufficient facts or data
- Testimony is the product of reliable principles and methods
- Expert has reliably applied principles to facts
- Methodology can be and has been tested
- Known or potential error rates exist and are disclosed
- Methodology has gained general acceptance in relevant scientific community

These criteria, adapted from Daubert and Federal Rules of Evidence 702, would provide judges with concrete guidance while remaining flexible for new scientific developments. Figure 2 illustrates the proposed admissibility framework incorporating these standards

Fig 2. Proposed Admissibility Framework:



7.2. Institutional Reforms

Establishing an independent Forensic Science Commission represents crucial institutional reform. This body would develop and enforce standards, accredit laboratories, certify practitioners, conduct research on methods, investigate misconduct, and advise courts. The Commission should include scientists, statisticians, legal experts, and judicial members. Mandatory accreditation of all forensic laboratories under ISO/IEC 17025 should be implemented within five years. Laboratories should be organizationally separated from investigative agencies to minimize bias through independent directors, separate budgets, and prohibition on investigator influence over analysis.

7.3. Professional Standards

Professional certification requirements should be established for forensic practitioners, with discipline-specific boards setting educational requirements, conducting examinations, and maintaining certification through continuing education. Comprehensive training must address technical skills, cognitive bias mitigation, statistical reasoning, limitations disclosure, and ethical responsibilities. Judicial education programs on forensic science are essential, as most judges lack scientific training yet must evaluate complex evidence.

7.4. Research and Validation

Establishing a national forensic science research program is essential for generating empirical data on method validity, error rates, and best practices adapted to Indian conditions. Research priorities should include validation studies of pattern-matching techniques under operational conditions, comprehensive error rate determination across forensic disciplines through proficiency testing and review of casework, effectiveness evaluation of quality control measures and blind testing protocols, and development of improved methodologies incorporating recent scientific advances. This research agenda must be adequately funded and insulated from political pressure to produce predetermined results. Partnerships between forensic laboratories, universities, and research institutions can leverage existing scientific infrastructure while building forensic-specific expertise. International collaboration through bilateral agreements and participation in global forensic science networks can facilitate knowledge transfer and adoption of best practices while avoiding unnecessary duplication of research efforts.

7.5. Procedural Safeguards

Implementing blind testing procedures can minimize confirmation bias, with examiners analyzing evidence without knowledge of suspect identity or investigative theories. Standardized reporting requirements should mandate disclosure of methodologies, limitations, alternative hypotheses, statistical uncertainties, and examiner qualifications. Enhanced discovery rights for defense counsel regarding forensic evidence are necessary, including complete reports, underlying data, examiner qualifications, laboratory quality control records, and proficiency test results.

7.6. Implementation Challenges

Implementing these reforms faces significant challenges. Resource constraints affect both forensic infrastructure and judicial capacity. India's forensic laboratories already face massive case backlogs, with some facilities reporting turnaround times exceeding six months for routine analyses. Requiring additional quality controls, proficiency testing, and accreditation processes will initially increase costs and processing times, though long-term benefits in reliability and reduced appeals should offset these burdens.

Political resistance may emerge from stakeholders invested in current arrangements. Police and prosecution agencies may resist reforms that could exclude currently admissible evidence or create additional procedural requirements. Some forensic practitioners may oppose certification requirements or external oversight, viewing them as threats to professional autonomy. Judges may be reluctant to undertake gatekeeping responsibilities for scientific evidence given their limited scientific training. Overcoming these sources of resistance requires sustained advocacy, demonstration projects showing feasibility, and perhaps most importantly, highlighting how current deficiencies harm both prosecution and defense interests through unreliable evidence and lengthy appeals. When stakeholders understand that reforms serve accuracy and efficiency rather than favoring one side, resistance typically diminishes.

VIII. CONCLUSION

Forensic evidence occupies a peculiar position in criminal justice, promising scientific certainty while often delivering subjective interpretation cloaked in technical language. India's forensic infrastructure and legal framework have failed to address this tension, perpetuating outdated assumptions about scientific infallibility while lacking mechanisms to distinguish valid science from pseudoscience. This paper has documented systematic deficiencies across legislative, institutional, and procedural dimensions. The Indian Evidence Act provides no scientific validity criteria, courts lack frameworks for evaluating reliability, forensic laboratories operate without mandatory quality standards, practitioners face no certification requirements, and procedural safeguards against bias remain absent.

Reform requires multi-faceted intervention addressing law, institutions, and practice. Legislative amendments should establish explicit reliability standards drawn from international best practices. An independent Forensic Science Commission should oversee quality standards, laboratory accreditation, and practitioner certification. Procedural reforms including blind testing, enhanced reporting requirements, and improved discovery can mitigate cognitive bias and information asymmetries. Implementation challenges include resource constraints, political resistance, and cultural factors including faith in expert authority. However, these challenges are surmountable, and the costs of inaction exceed the costs of reform.

The ultimate goal is a criminal justice system where forensic evidence serves truth rather than predetermined conclusions, where scientific claims are rigorously validated rather than accepted on authority, and where safeguards protect against both wrongful convictions and wrongful acquittals. Future research should examine ground-level implementation, assess effectiveness of quality control mechanisms in Indian contexts, investigate cultural and institutional barriers to change, and develop cost-effective capacity building approaches. India stands at a crossroads requiring commitment to scientific integrity, institutional independence, and procedural fairness. Only through collective effort among the forensic science community, judiciary, legal profession, and policymakers can India ensure that forensic evidence meets the rigorous standards that justice demands.

The path forward requires recognizing that forensic evidence, while potentially powerful, is neither infallible nor self-interpreting. Scientific methods must be rigorously validated, quality controls must be systematically enforced, and expert testimony must be carefully evaluated. These requirements do not undermine forensic science but rather strengthen it, ensuring that when courts rely on scientific evidence, that reliance is justified by actual scientific rigor rather than mere assertions of expertise. India's criminal justice system deserves nothing less than forensic evidence that has been tested, validated, and subjected to the same scrutiny demanded of scientific claims in other contexts. Achieving this standard will require sustained effort, substantial investment, and willingness to challenge entrenched practices, but the alternative—continuing to rely on unreliable evidence—is simply unacceptable in a system committed to justice.

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