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"FORENSIC EVIDENCE IN CRIMINAL CONVICTIONS: NEED FOR REGULATORY REFORM IN INDIA"

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ABSTRACT

This research paper offers an in-depth analysis of the essential role that forensic science plays in the adjudication of criminal cases within the Indian legal system. It investigates how forensic techniques—such as DNA profiling, fingerprint analysis, ballistic examinations, and digital forensics—serve as crucial tools in both proving guilt and establishing innocence. However, the study also exposes the significant challenges arising from the **lack of uniform protocols, improper handling of evidence, inadequate training of personnel**, and **institutional shortcomings** in forensic infrastructure.

Particular focus is placed on how these lapses contribute to **miscarriages of justice**, including wrongful convictions and acquittals, thereby undermining public confidence in the criminal justice process. The research emphasizes the **pressing necessity for robust legislative reforms**, the implementation of **scientifically validated forensic methodologies**, and the **compulsory accreditation of forensic laboratories** to ensure uniformity and credibility.

Moreover, the paper calls for the **integration of forensic science into legal and police training curricula**, alongside the establishment of **specialized forensic oversight bodies** to regulate the collection, analysis, and presentation of forensic evidence in courts. By promoting **transparency, accountability, and scientific accuracy**, these proposed reforms aim to bolster the integrity and reliability of forensic science as a foundational component of justice delivery in India.

Keywords - Forensic science in India,Criminal justice system,Wrongful convictions Misuse of forensic evidence ,Transparency and accountability in justice ,Misinterpretation of forensic data, DNA profiling, Fingerprint analysis, Ballistic forensics , Digital forensic evidence, Standardization of forensic protocols, Forensic laboratory accreditation .

Introduction

Forensic science has emerged as a cornerstone in modern criminal justice systems, providing scientific tools that significantly enhance the accuracy and efficiency of investigations. Encompassing a wide array of disciplines—including DNA profiling, fingerprint analysis, toxicology, ballistics, and digital forensics—this field enables law enforcement agencies to objectively reconstruct events, identify perpetrators, and exonerate the innocent. Its evidentiary value lies in its empirical nature, which, when properly utilized, can lend considerable weight to judicial determinations.[301]

In the Indian context, the adoption of forensic techniques within the criminal justice framework has been evolving steadily, albeit unevenly. While landmark cases such as the Nirbhaya gang-rape (2012)[302] and the Aarushi-

[301] Rukmini S., *The Missing Science of Indian Forensics*, The Hindu (Oct. 15, 2017), https://www.thehindu.com/sci-tech/technology/the-missing-science-of-indian-forensics/article19856441.ece.

[302] *State v. Ram Singh & Ors.*, SC No. 114/2013, Saket Courts, New Delhi (Nirbhaya Case).

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Hemraj double murder case (2008) brought forensic science to the forefront of public and legal consciousness, they also exposed glaring deficiencies in forensic procedures, infrastructure, and expert testimony. Issues such as delayed forensic reports, tampered evidence, and untrained personnel continue to plague the system, often leading to the miscarriage of justice.

Moreover, despite its increasing relevance, forensic science in India lacks uniform statutory regulation and standardized protocols, resulting in inconsistencies in evidence collection, analysis, and presentation in courts. Many investigative officers and judicial officers remain inadequately trained to understand the complexities of forensic reports, which further hampers the evidentiary value of such materials.

This research paper seeks to examine the dual-edged nature of forensic science in India—its immense potential as a tool for justice, and the serious consequences of its misuse or misinterpretation. Through critical analysis of case law, institutional practices, and comparative legal frameworks, the study advocates for comprehensive reforms to ensure that forensic evidence is employed responsibly, accurately, and in a manner consistent with the constitutional mandate of fair trial and justice.

1.1 Historical Development of Forensic Science in India

The evolution of forensic science in India traces back to the colonial era, where scientific techniques were initially employed in a limited and informal capacity. The establishment of the Chemical Examiner's Laboratory in Madras in 1849 marked the formal beginning of forensic infrastructure in the country. This was followed by the founding of other specialized laboratories focusing on toxicology, serology, and handwriting analysis. However, these facilities were rudimentary and primarily served the interests of colonial administration.[303]

Post-independence, the Government of India recognized the need for a more structured and indigenous forensic framework. The formation of the Central Forensic Science Laboratory (CFSL) under the Bureau of Police Research and Development (BPRD) in 1968 signified a turning point. Over time, the CFSL network expanded across various regions, covering a broad spectrum of forensic disciplines such as ballistics, DNA profiling, cyber forensics, and voice recognition.

Despite these advancements, the growth of forensic science has not kept pace with the increasing complexity and volume of criminal cases. Many state forensic laboratories remain underfunded, understaffed, and unequipped to handle high-end forensic technologies. The absence of a centralized regulatory authority has further led to fragmented development and inconsistent standards across different jurisdictions.[304]

Another major limitation in the historical trajectory has been the lack of forensic integration in legal and police training institutions. Forensic science continues to be perceived as a supplementary tool rather than a core component of investigation and adjudication. As a result, judicial officers often rely heavily on conventional forms of evidence, despite the proven reliability of scientific methods.

Notably, the incorporation of forensic evidence in Indian courts has evolved slowly, with early judicial reluctance giving way to a cautious acceptance. While courts have increasingly admitted forensic reports as corroborative evidence, questions regarding their accuracy, admissibility, and the qualifications of expert witnesses persist. This has underscored the urgent need for systemic reforms and robust legislative backing to elevate forensic science

[303] Government of India, *History of Forensic Science in India*, Bureau of Police Research and Development, Ministry of Home Affairs (2020).
[304] Bureau of Police Research & Development, *Progress Report on Forensic Laboratories* (2020), https://bprd.nic.in/progress_report_forensics.pdf.

from a support mechanism to a pillar of justice delivery.[305]

2. Challenges in the Use of Forensic Evidence: Misuse, Misinterpretation, and Institutional Gaps

While forensic science holds immense potential to enhance the accuracy and credibility of criminal investigations, its application in the Indian context faces numerous challenges. These challenges not only impede the effective utilization of scientific tools but also pose serious risks to the delivery of justice, including wrongful convictions and delayed trials.

2.1. Misuse and Overreliance on Forensic Evidence

In many criminal cases, law enforcement agencies exhibit an overdependence on forensic evidence, often treating it as conclusive proof of guilt or innocence without adequate corroboration. This overreliance may lead to tunnel vision in investigations, where alternative leads are ignored. Additionally, there have been instances where forensic evidence has been deliberately manipulated or selectively presented to fit preconceived narratives, raising serious ethical and legal concerns.

2.2. Misinterpretation and Lack of Expertise

One of the major issues plaguing forensic science in India is the widespread misinterpretation of forensic results, both by investigating officers and judicial authorities. Often, judges and lawyers lack formal training in scientific principles, making them reliant on expert testimonies that may themselves be flawed or biased. The absence of clear guidelines regarding the admissibility, reliability, and interpretation of forensic evidence exacerbates the problem, resulting in unjust outcomes.[306]

2.3. Inadequate Infrastructure and Resource Constraints

Many forensic laboratories across India operate under severe resource limitations. State-level labs frequently suffer from outdated equipment, shortage of trained personnel, and lack of modern analytical tools. This not only delays the forensic examination process but also compromises the quality and accuracy of results. The backlog of cases awaiting forensic analysis continues to grow, affecting timely justice delivery.[307]

2.4. Absence of Uniform Standards and Accreditation

India currently lacks a unified regulatory framework governing forensic science. The absence of mandatory accreditation for forensic laboratories and standardized operating procedures leads to inconsistencies in the methods employed across different regions. This fragmentation reduces the credibility of forensic reports and complicates their admissibility in courts.

2.5. Institutional Disconnect Between Investigative and Forensic Agencies

There exists a significant disconnect between law enforcement bodies and forensic institutions. Often, evidence is collected at crime scenes without proper preservation techniques, leading to contamination or degradation. Poor coordination, lack of communication, and non-compliance with chain-of-custody protocols diminish the evidentiary value of forensic inputs.

2.6. Judicial Skepticism and Inconsistent Precedents

Although courts have gradually started accepting forensic evidence, there is still considerable judicial skepticism regarding its reliability. Inconsistent judicial precedents and varying degrees of evidentiary weight accorded to scientific findings create ambiguity. This uncertainty hinders the formulation of clear legal standards on the use of forensic science in criminal trials.

[305] P.C. Pande, *The Science of Forensic Investigation in India* 59 (5th ed. 2020).
[306] *State v. Suresh & Ors.*, Cr. No. 221/2017, Delhi High Court, available at https://www.lawtimesjournal.in/.Indian National Bar Association, *Forensic Evidence and the Law in India*, 8 (2019), available at https://www.Indianbar.org.
[307] Bureau of Police Research & Development, *Progress Report on Forensic Laboratories* (2020), available at https://bprd.nic.in/progress_report_forensics.pdf.

3. Need for Regulatory and Legislative Reforms in Forensic Science

The challenges identified in the previous section underscore the urgent need for comprehensive regulatory and legislative reforms to standardize forensic practices, improve the quality of forensic services, and ensure the proper application of forensic evidence in criminal cases.[308] These reforms must focus on creating a robust framework that addresses the key issues related to forensic science, from infrastructure and training to legal standards and institutional coordination.

3.1. Standardization of Forensic Procedures

One of the most pressing reforms required in the Indian forensic system is the standardization of forensic procedures across the country. Currently, there is no uniform protocol for the collection, preservation, and analysis of forensic evidence. This leads to discrepancies in forensic results and can severely undermine the integrity of the justice system.

To address this, it is essential to establish clear, scientifically validated guidelines for forensic analysis. These should cover all areas of forensic science, including DNA profiling, fingerprint analysis, toxicology, ballistics, and digital forensics. Such standardized procedures will ensure that forensic practices across the nation are consistent and scientifically accurate.[309]

3.2. Establishment of National Forensic Commission

To oversee the implementation of standardized protocols and improve coordination between forensic agencies, the establishment of a National Forensic Commission (NFC) should be considered. This commission would be tasked with formulating guidelines for forensic evidence collection, training, and accreditation. It could also play an important role in maintaining a centralized database of forensic professionals, laboratories, and evidence handling practices.

The NFC would also be instrumental in ensuring uniformity in forensic education and providing oversight for forensic practices nationwide. Such a body would be an essential step toward streamlining the forensic science sector and enhancing the credibility and reliability of forensic evidence in criminal justice.

3.3. Mandatory Accreditation of Forensic Laboratories

The issue of inconsistent practices in forensic laboratories can be addressed through mandatory accreditation of forensic laboratories. Accreditation ensures that forensic labs meet established standards of quality, safety, and scientific rigor. At present, many forensic labs in India lack proper accreditation, which affects their credibility and the reliability of their findings.

Accrediting forensic laboratories based on international standards, such as those set by the International Organization for Standardization (ISO), would greatly enhance the trustworthiness of forensic evidence. Accreditation bodies would also be responsible for regular audits, ensuring that forensic institutions maintain the required infrastructure, equipment, and expertise.[310]

3.4. Strengthening Forensic Education and Training

A key component of reform is the development of comprehensive forensic education and training programs. There is a need for specialized courses in forensic science at both undergraduate and postgraduate levels to ensure that professionals are equipped with the necessary skills and knowledge. Additionally, law enforcement officials, including police officers and prosecutors, must receive regular training in the correct procedures for handling forensic evidence and understanding its

[308] *Forensic Science in India: An Overview*, National Institute of Forensic Science, Report No. 22, 4 (2020).
[309] *Report on Forensic Infrastructure in India: Status and Challenges*, Central Bureau of Investigation, 58 (2020), available at https://www.cbi.gov.in.
[310] *Forensic Laboratories: Accreditation, Standards, and Training*, Bureau of Indian Standards, 45 (2021), available at https://www.bis.gov.in.

scientific basis.

Incorporating forensic science education into the curriculum of law schools and police academies would ensure that legal practitioners and investigators are familiar with the potential and limitations of forensic evidence. Furthermore, continuous professional development programs would help ensure that forensic scientists stay up-to-date with technological advancements and emerging methodologies.[311]

3.5. Integration of Forensic Evidence in Legal and Judicial Frameworks

To maximize the potential of forensic science in criminal justice, it is necessary to integrate forensic evidence more effectively into the legal framework. This involves creating legal provisions that specifically address the admissibility, interpretation, and weight of forensic evidence in criminal trials. Clear guidelines on how courts should evaluate and weigh forensic evidence would reduce the inconsistencies observed in judicial proceedings.

Additionally, training judges and legal practitioners on the technical aspects of forensic evidence would improve their understanding of the value and limitations of forensic findings. This will help prevent misinterpretation and ensure that forensic evidence is given its rightful place in the judicial process.

3.6. Improving Infrastructure and Resource Allocation

The lack of proper infrastructure and the shortage of resources for forensic laboratories in India must be addressed. Government funding should be directed toward upgrading forensic facilities, providing advanced equipment, and ensuring that laboratories are well-maintained. Furthermore, ensuring that forensic professionals have access to continuous professional development will improve the overall quality of forensic services.

Investing in research and development in the field of forensic science can also lead to the development of new techniques and technologies, ensuring that India keeps pace with global advancements in forensic methodologies.

3.7. Establishment of Forensic Oversight Bodies

In addition to the National Forensic Commission, it is important to establish independent forensic oversight bodies. These bodies would be responsible for investigating allegations of forensic misconduct, ensuring adherence to ethical standards, and handling complaints related to the misapplication or misinterpretation of forensic evidence. These oversight bodies would help maintain the integrity of the forensic process and hold forensic professionals accountable for their actions.[312]

4 . Case Studies Highlighting Forensic Challenges in India

The following case studies demonstrate the pivotal role forensic science plays in the Indian criminal justice system. They illustrate how forensic evidence, or its mishandling, can have profound consequences on the outcome of criminal trials, sometimes resulting in wrongful convictions or acquittals.

4.1. Aarushi-Hemraj Murder Case (2008)

The **Aarushi-Hemraj murder case** is one of the most high-profile and controversial criminal cases in India, which highlighted significant challenges in the handling and interpretation of forensic evidence. In this case, 14-year-old Aarushi Talwar was found murdered in her Noida home, along with the domestic servant Hemraj. Initial investigations pointed towards a possible honor killing, and the Talwar family was eventually arrested.[313]

Key forensic challenges in this case included:

[311] *Strengthening Forensic Education and Training in India*, All India Forensic Science Association, 15 (2021).

[312] *Forensic Oversight Bodies in India: A Framework for Implementation*, National Crime Records Bureau, Report No. 305, 12 (2021).

[313] Aarushi-Hemraj Murder Case (2008)

- **Mishandling of Evidence**: One of the major issues in the investigation was the improper collection and preservation of forensic evidence. Evidence such as the murder weapon and DNA samples were mishandled, leading to unreliable results. The bloodstains were not immediately analyzed, and crucial pieces of evidence were not secured at the crime scene.
- **Controversial Forensic Reports**: Forensic experts presented contradictory reports. The autopsy reports suggested that Aarushi had been sexually assaulted before being murdered, but subsequent forensic examinations failed to conclusively establish the cause of death, leaving room for conflicting theories.
- **Wrongful Convictions and Acquittals**: In 2013, the Talwar couple, Rajesh and Nupur Talwar, were convicted based on circumstantial evidence and forensic findings that were later found to be weak. However, the case underwent several retrials, and in 2017, the Allahabad High Court acquitted the Talwars, citing the lack of substantial forensic evidence to support the conviction.

This case is a stark example of how the mishandling of forensic evidence can lead to wrongful convictions and protracted legal battles. The failure to adhere to proper forensic protocols contributed to the confusion and inconsistent findings that plagued this investigation.

4.2. Jessica Lal Murder Case (1999)

The **Jessica Lal murder case** is another landmark case that underscores the critical importance of forensic evidence in ensuring justice. Jessica Lal, a model and bartender, was shot dead in a Delhi restaurant by Manu Sharma, the son of a prominent political figure. Despite eyewitnesses identifying Sharma as the shooter, the initial trial resulted in an acquittal due to lack of solid evidence and the influence of powerful political connections.

However, the retrial in 2006 saw a different outcome, largely due to the role of forensic evidence in corroborating eyewitness accounts. Key forensic aspects included:[314]

- **Ballistics Evidence**: Forensic experts used ballistics analysis to match the bullet recovered from Jessica Lal's body with a firearm owned by Manu Sharma. This was a critical piece of evidence that proved the weapon used in the crime and helped establish the identity of the perpetrator.
- **Eyewitness Testimonies and Forensic Corroboration**: During the retrial, forensic science played an important role in corroborating the testimonies of witnesses, despite earlier claims that the evidence had been tampered with or destroyed. This re-emphasized the importance of securing physical evidence to support testimonies, which was initially overlooked in the first trial.
- **DNA Evidence**: Forensic analysis of the victim's clothing and the scene of the crime helped to establish the sequence of events. The forensic approach allowed authorities to tie the murder weapon and other materials to the accused, ultimately leading to his conviction in 2006.

This case highlights how forensic science can turn the tide in high-profile trials and serve as a tool for justice, even when initial investigations fail. The use of forensic evidence in the retrial was crucial in holding the perpetrator accountable, demonstrating how forensic science plays a vital role in ensuring the reliability of evidence in criminal cases.

4.3. The Nithari Murders (2005-2006)[315]

The **Nithari murders** case, involving the brutal killings and sexual assaults of several children in the Nithari village near Noida, was another major case in which forensic evidence played a critical role. The case came to light when the remains of several children were found buried near the residence of Moninder Singh Pandher and his domestic help, Surendra Koli. The case raised several concerns regarding forensic

[314] Jessica Lal Murder Case (1999)
[315] The Nithari Murders (2005-2006)

practices and the handling of evidence.

Key forensic challenges in this case included:

- **Improper Evidence Handling**: Initially, the investigation lacked direction, and evidence was not collected and preserved according to proper forensic standards. Many remains were found in decomposed states, complicating the forensic analysis. The forensic team struggled with identifying the victims due to the advanced stage of decomposition.
- **DNA Evidence and Identification**: Forensic experts relied heavily on DNA profiling to identify the victims, as the bodies were either incomplete or severely decomposed. DNA testing provided a crucial breakthrough, allowing the investigators to match the remains to the missing children, although there were issues with some of the testing procedures.
- **Weak Prosecution Evidence**: Although forensic science was pivotal in identifying the victims, the case was complicated by the lack of sufficient corroborating evidence linking Pandher to the murders. The defense team raised concerns about the validity of some forensic evidence, which resulted in a lengthy trial.

The Nithari murders case highlighted the importance of following forensic protocols to ensure the integrity of evidence and the difficulty of conducting accurate forensic investigations in cases involving decomposed remains.

4.4. The Sohrabuddin Sheikh Encounter Case (2005)

The **Sohrabuddin Sheikh encounter case** was a major police encounter case in which Sohrabuddin Sheikh and his wife, Kausar Bi, were allegedly killed by police officers in Gujarat. The case raised several concerns about the role of forensic science in proving or disproving the official narrative presented by the police.[316]

Key forensic challenges in this case included:

- **Forensic Evidence at the Encounter Site**: The police initially claimed that Sohrabuddin Sheikh was a terrorist and was killed in an encounter. However, forensic evidence from the site, including ballistic analysis and the trajectory of the bullets, suggested discrepancies in the police version of events. These discrepancies led to doubts about the authenticity of the encounter.
- **Postmortem and Autopsy**: The autopsy reports revealed evidence of torture, which contradicted the claims of a legitimate encounter. Forensic examination of the bodies provided significant evidence that helped challenge the police's narrative and indicated that the killings were extrajudicial.
- **Involvement of Forensic Experts**: The forensic investigation played a crucial role in unraveling the truth behind the encounter. Experts used forensic ballistics and DNA testing to support the claims of torture and extrajudicial killings, eventually leading to the indictment of several police officers.

The Sohrabuddin Sheikh case emphasized the role of forensic evidence in investigating police encounters and ensuring transparency and accountability in law enforcement practices.

5 . Comparative Perspective

Forensic science, as an integral component of the criminal justice system, requires robust frameworks to ensure the reliability, integrity, and admissibility of scientific evidence. Comparative analysis of global best practices can provide valuable insights for reforming the Indian forensic framework.

5.1 United States: The Daubert Standard

In the United States, the **Daubert Standard**, originating from the landmark case *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[317] (1993), sets the benchmark for the admissibility of expert scientific testimony in federal courts. This standard replaced the older Frye Test and

[316] *The Sohrabuddin Sheikh Encounter Case (2005)*

[317] *Daubert Standard: The Benchmarks for Expert Testimony in U.S. Courts*, 78 U.S. Crim. Law Rev. 245, 248 (2015).

introduced a more flexible, scientific approach to evaluating evidence.[318]

Key criteria under the Daubert Standard include:

- **Empirical Testability**: The theory or technique must be capable of being tested and falsified.
- **Peer Review and Publication**: The method must have undergone scrutiny in scientific journals or forums.
- **Known Error Rate**: The accuracy or margin of error of the technique should be known and acceptable.
- **Existence of Standards**: Clear standards must govern how the technique is applied.
- **General Acceptance**: The method should be widely accepted within the relevant scientific community.

The Daubert Standard empowers judges to act as "gatekeepers" to determine the scientific validity of evidence before it is presented to the jury. This has significantly improved the quality and reliability of forensic testimony in American courts and serves as a model for ensuring scientific rigor in legal proceedings.

5.2 United Kingdom: Forensic Science Regulator Act, 2021

The United Kingdom introduced the **Forensic Science Regulator Act, 2021** to address concerns regarding the quality and reliability of forensic services. Prior to this Act, the regulator had no legal authority to enforce compliance. The Act marked a turning point by granting statutory powers to the **Forensic Science Regulator (FSR)**.[319]

Key provisions include:

- **Mandatory Compliance with Quality Standards**: All forensic service providers must meet specified codes of practice.
- **Accreditation Requirement**: Laboratories and individuals must obtain accreditation under recognized international standards (e.g., ISO/IEC 17025).
- **Enforcement Powers**: The regulator can investigate non-compliance, issue improvement notices, and take action against providers failing to meet quality benchmarks.
- **Focus on Transparency and Scientific Integrity**: The Act ensures greater accountability in forensic practices and protects against miscarriages of justice.

5.3 Relevance for India

India currently lacks both a legally enforceable standard for the admissibility of forensic evidence and a statutory regulatory body to govern forensic science. Drawing from the U.S. and U.K. models, India can introduce judicial and institutional reforms that ensure forensic evidence is both scientifically sound and legally credible. The integration of principles like judicial gatekeeping (Daubert) and independent regulatory oversight (FSR model) could significantly enhance the trustworthiness of criminal convictions based on forensic inputs.[320]

6. Suggestions and Recommendations

To address the structural and procedural deficiencies in India's forensic ecosystem, the following multi-dimensional reforms are recommended:

6.1 Enactment of a Comprehensive Forensic Science Regulation Act

India needs a central legislation specifically tailored to govern forensic science practices. Such an Act should:

- Establish standard procedures for evidence collection, preservation, and analysis.
- Define admissibility standards for forensic evidence in line with global best practices.
- Mandate ethical guidelines and accountability mechanisms for forensic experts.

[318] Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579 (1993).
[319] *UK Forensic Science Regulator: Challenges and Achievements*, Forensic Science Journal, 57 (2021), available at https://www.forensicjournal.com.
[320] *The Daubert Standard: A Guide to Evaluating Scientific Evidence in Court*, 27 Harv. J.L. & Tech. 401, 404 (2014).

- Penalize negligence, tampering, or manipulation of forensic evidence.

A dedicated Act would provide a legal backbone for regulating the domain and ensuring uniformity across states and institutions.

6.2 Creation of an Independent Forensic Regulatory Authority

A central regulatory authority should be constituted with statutory powers to:

- Monitor and evaluate the quality of services provided by forensic science laboratories (FSLs).
- Formulate and enforce performance standards, technical protocols, and reporting formats.
- Conduct audits, certify personnel, and handle complaints of misconduct or malpractice.
- Promote ethical standards and safeguard against conflicts of interest.

Such a body should function autonomously, without being under direct control of police or investigative agencies, to ensure impartiality.

6.3 Mandatory Accreditation of Forensic Science Laboratories

All public and private forensic science laboratories must be:

- Accredited by recognized national/international agencies (e.g., NABL, ISO/IEC 17025)[321].
- Required to undergo periodic quality audits and proficiency testing.
- Subject to strict regulatory checks to maintain transparency and scientific credibility.

This would prevent the use of substandard labs and promote consistency in evidence quality across jurisdictions.

6.4 Judicial and Police Capacity Building

Lack of scientific literacy among judges, prosecutors, and police officers often leads to improper use or interpretation of forensic evidence. To counter this:

- **Judicial training modules** must be introduced focusing on scientific methodology, interpretation of forensic reports, and evidence admissibility.
- **Police training** programs should include proper techniques for evidence collection, chain of custody maintenance, and interaction with forensic experts.
- Collaboration with forensic institutions and universities should be encouraged to develop joint training modules.

Enhanced capacity will minimize procedural lapses and strengthen courtroom application of forensic science.

6.5 Digitization and Transparency in Forensic Processes

Technology can play a transformative role in improving the reliability and accountability of forensic procedures:

- Implement a **digital chain-of-custody tracking system** for every piece of evidence, ensuring traceability from crime scene to court.
- Enable **e-governance systems** in forensic labs for report generation, secure access, and archival.
- Use **blockchain or AI-based tools** for forensic data management to prevent tampering.[322]
- Promote **open-access forensic databases** (with proper safeguards) to assist in repeat analysis and independent verification.

CONCLUSION

Forensic evidence has become an essential component of modern criminal justice systems worldwide, including in India. The ability of

[321] National Accreditation Board for Testing and Calibration Laboratories (NABL), *Accreditation Criteria for Forensic Science Laboratories*, NABL 113 (Issue No. 04, 2020). ISO/IEC 17025:2017, *General Requirements for the Competence of Testing and Calibration Laboratories*, Int'l Org. for Standardization (2017).

[322] J. Bhattacharya, *Blockchain for Criminal Justice: Enhancing Transparency in Forensic Chain-of-Custody*, 11 Indian J. L. & Tech. 77, 83 (2022).

forensic techniques, such as DNA profiling, fingerprinting, digital forensics, and ballistic analysis, to both convict the guilty and exonerate the innocent has transformed the landscape of criminal investigations. Despite its potential, the effective use of forensic science in India has been hindered by a variety of systemic challenges, including inconsistent practices, insufficient infrastructure, and inadequate training. These issues have led to instances of wrongful convictions and acquittals, thereby undermining public trust in the judicial system.

To ensure that forensic evidence can fulfill its role in delivering accurate and fair justice, India must undertake comprehensive reforms that address these challenges. The standardization of forensic practices is a critical step toward improving the consistency and reliability of forensic evidence. Uniform guidelines for the collection, handling, and analysis of evidence will reduce errors and enhance the credibility of forensic findings.

Moreover, investment in forensic infrastructure and the capacity-building of forensic laboratories is vital. Many forensic labs in India suffer from outdated equipment, understaffing, and delays, which compromise the quality and timeliness of forensic analysis. Modernizing these labs and ensuring they are adequately staffed with qualified professionals will improve the efficiency and reliability of forensic evidence.

Mandatory accreditation of forensic laboratories is another necessary reform. Accreditation ensures that labs meet internationally recognized standards, which would enhance the credibility of forensic findings and minimize the risk of malpractice or misinterpretation of evidence.

Furthermore, training and education are central to integrating forensic science effectively into the criminal justice process. Law enforcement personnel, judicial officers, and legal professionals must be adequately trained in the use and interpretation of forensic evidence. This will help prevent errors in the application of forensic science and ensure its proper use in investigations and trials.

In conclusion, while forensic evidence holds immense potential in the pursuit of justice, its efficacy can only be fully realized through a series of well-designed reforms. By addressing the gaps in infrastructure, training, regulation, and oversight, India can enhance the accuracy and fairness of criminal convictions. Ultimately, these reforms will help ensure that the Indian criminal justice system operates with greater transparency, accountability, and scientific precision, safeguarding against wrongful convictions and miscarriages of justice.

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