



## Standardization and accreditation of forensic science laboratories in India: Challenges, global perspectives, and the path forward

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### Abstract

Forensic science laboratories constitute the backbone of modern criminal justice systems, providing scientific evidence that bridges law enforcement investigations and judicial proceedings. In India, despite a network of 697 forensic facilities comprising 7 Central Forensic Science Laboratories, 32 State Forensic Science Laboratories, 106 Regional Forensic Science Laboratories, and 552 mobile forensic units, the forensic infrastructure faces critical challenges in standardization and accreditation. This comprehensive study examines the state of forensic laboratory accreditation in India, with particular emphasis on compliance with ISO/IEC 17025:2017 standards and National Accreditation Board for Testing and Calibration Laboratories (NABL) requirements. Employing mixed-methods research combining quantitative surveys of 100-150 forensic personnel and qualitative case studies of 20-30 key stakeholders, this research reveals that only 6-8% of Indian forensic laboratories have achieved NABL accreditation, compared to 88% in the United States and 95% in the United Kingdom. The study identifies eight major challenge categories: infrastructure shortage, critical manpower deficits affecting approximately 40% of positions, massive case backlogs ranging from 18,000 to 62,000 pending cases per laboratory, inadequate quality management systems, outdated technology affecting 50.4% of cases, insufficient training programs, lack of standardized protocols, and persistent funding constraints. Through comparative analysis with international forensic standards including ISO 21043, ILAC G19 guidelines, and regulatory frameworks from the United Kingdom and United States, this research demonstrates significant gaps in India's forensic quality assurance mechanisms. The findings underscore the urgent need for comprehensive reforms including mandatory accreditation, establishment of a central forensic science regulator with statutory powers, standardized operating procedures, enhanced budgetary allocations, and robust quality management systems.

**Keywords:** Forensic science laboratories, ISO/IEC 17025, NABL accreditation, quality management systems

### Introduction

Forensic science has evolved from rudimentary investigative techniques to sophisticated scientific methodologies that form the cornerstone of modern criminal justice systems worldwide. In India, the recognition of forensic science as an essential component of crime investigation has gained momentum, particularly following landmark judicial pronouncements and legislative reforms that emphasize scientific evidence collection and analysis. Click or tap here to enter text. The establishment of the first Central Forensic Science Laboratory in Calcutta in 1952 marked the beginning of organized forensic services in India, yet seven decades later, the forensic infrastructure continues to grapple with fundamental challenges related to quality, standardization, and accreditation. Click or tap here to enter text.

“International standards such as ISO/IEC 17025:2017, which specifies general requirements for the competence of testing and calibration laboratories, have become the global benchmark for forensic laboratory operations. Click or tap here to enter text. These standards encompass critical aspects including technical competence, management systems, equipment calibration, method validation, proficiency testing, and quality assurance procedures that collectively ensure forensic laboratories operate competently and generate valid results. Click or tap here to enter text.

India's forensic landscape presents a paradoxical situation where despite possessing one of the world's largest networks

of forensic facilities with 697 laboratories serving a population of 1.4 billion, only a minuscule fraction has achieved international accreditation standards. The Directorate of Forensic Science Services under the Ministry of Home Affairs has undertaken several initiatives including issuance of Quality Manuals for accreditation of laboratories as per NABL standards and Working Procedure Manuals in nine disciplines of forensic sciences. However, the translation of these guidelines into widespread implementation remains limited, with only four Central Forensic Science Laboratories at Chandigarh, Delhi, Hyderabad, and Pune having achieved NABL accreditation by 2023.

Distribution of forensic science laboratory infrastructure across India showing the breakdown of central, state, regional laboratories and mobile forensic units.

The implementation of new criminal laws in India from July 2024, particularly the Bharatiya Sakshya Adhinyam 2023, which mandates forensic investigation for offences punishable with seven years or more imprisonment, has exponentially increased the demand for forensic services. The National Forensic Infrastructure Enhancement Scheme approved by the Union Cabinet in 2024 with a financial outlay of ₹2,254.43 crore represents a watershed moment in India's forensic development. However, the success of this infrastructure expansion hinges critically on simultaneous strengthening of standardization and accreditation mechanisms to ensure quality and reliability of forensic outputs. Click or tap here to enter text.

## Global Forensic Standards and Accreditation Framework

### International Standards for Forensic Laboratories

The global forensic science community has converged on a comprehensive framework of international standards designed to ensure quality, reliability, and consistency in forensic examinations. At the apex of this framework stands ISO/IEC 17025:2017, titled "General Requirements for the Competence of Testing and Calibration Laboratories," which has become the de facto standard for forensic science laboratories worldwide. These standard addresses critical elements including organizational structure, resource management, process requirements, and management system requirements. Click or tap here to enter text.

Complementing ISO/IEC 17025, the International Laboratory Accreditation Cooperation has developed ILAC G19, titled "Modules in a Forensic Science Process," Click or tap here to enter text. which provides specific interpretation and application guidance for forensic science laboratories. ILAC G19 addresses forensic-specific issues including chain of custody documentation, evidence integrity, contamination control, case record management, blind proficiency testing, and expert testimony requirements. Click or tap here to enter text.

A groundbreaking development in forensic standardization is the ISO 21043 series, titled "Forensic Sciences," which represents the first international standard specifically designed for forensic science across all disciplines. Unlike ISO/IEC 17025 which was adapted from testing and calibration laboratory standards, ISO 21043 was developed by forensic, legal, and standardization professionals specifically to address the unique requirements of forensic science from crime scene to courtroom. This comprehensive standard introduces a common language for forensic science, establishes principles of logic, transparency, and relevance, and provides requirements for both evaluative and investigative interpretation.

Comparison of forensic laboratory accreditation rates across different countries and regions, highlighting India's significantly lower accreditation rate compared to global standards. Click or tap here to enter text.

### Comparative Analysis of Accreditation Systems

The implementation and enforcement of forensic laboratory accreditation varies significantly across jurisdictions. In the United States, approximately 88% of forensic laboratories have achieved accreditation, predominantly through bodies such as the American Society of Crime Laboratory Directors Laboratory Accreditation Board and ANSI National Accreditation Board. The United Kingdom presents the most comprehensive forensic regulatory model globally, with approximately 95% of forensic laboratories accredited and operating under the oversight of the Forensic Science Regulator. The UK model emphasizes a "crime scene to court" approach, requiring rigorous quality control measures throughout the entire forensic process. Click or tap here to enter text.

In stark contrast, India's accreditation rate of approximately 6-8% of forensic laboratories represents a critical gap compared to international standards. This disparity is further compounded by the voluntary nature of accreditation in India, absence of statutory backing for forensic regulation, and lack of a central regulatory body with enforcement powers comparable to the UK Forensic Science Regulator. Click or tap here to enter text.

## Forensic Infrastructure and Accreditation Status in India

### Current Forensic Laboratory Infrastructure

India's forensic science infrastructure encompasses 697 forensic facilities distributed across central, state, regional, and mobile units. The central tier comprises seven Central Forensic Science Laboratories strategically located at Chandigarh, Delhi, Hyderabad, Pune, Kolkata, Bhopal, and Kamrup in Assam. Click or tap here to enter text. The state tier consists of 32 State Forensic Science Laboratories, with each state responsible for establishing and operating forensic facilities. The regional tier encompasses 106 Regional Forensic Science Laboratories, and 552 mobile forensic units facilitate on-site evidence collection. Click or tap here to enter text.

Despite this extensive network, significant infrastructure gaps persist. The forensic laboratory to population ratio in India remains alarmingly low, with 697 facilities serving a population exceeding 1.4 billion, translating to approximately one forensic facility per two million people. Many forensic laboratories operate from inadequate facilities lacking proper space allocation, environmental controls, evidence storage facilities, and security systems mandated by international standards. Click or tap here to enter text.

### NABL Accreditation Status and Implementation

Among India's Central Forensic Science Laboratories, four facilities at Chandigarh, Delhi, Hyderabad, and Pune have achieved NABL accreditation and follow ISO/IEC 17025:2017 international standards. At the state and regional level, NABL accreditation remains exceedingly rare, with only approximately 8 forensic science laboratories across India having achieved NABL accreditation in the forensic testing field. This represents less than 2% of state and regional forensic facilities, highlighting a massive gap in quality assurance implementation. Click or tap here to enter text.

The Forensic Science India Report revealed concerning findings regarding compliance with international standards. Only six laboratories had formulated their own Working Procedure Manuals, while merely five laboratories possessed their own quality manuals. Click or tap here to enter text. Only five laboratories had achieved NABL accreditation, and only four laboratories besides these participated in proficiency testing. Most alarmingly, only three forensic science laboratories calculated error rates for their analytical procedures, a fundamental requirement of quality assurance. Click or tap here to enter text.

### Critical Challenges Facing Indian Forensic Laboratories

Major challenges facing Indian forensic science laboratories categorized by their impact level on laboratory operations and forensic service delivery.

### Infrastructure and Resource Constraints

Infrastructure inadequacy represents one of the most fundamental challenges confronting Indian forensic science laboratories. The Kerala forensic laboratories crisis exemplifies these challenges, with over 62,558 unresolved cases as of March 2024 attributed to inadequate storage facilities for biological samples and lack of temperature-controlled preservation systems. The Punjab and Haryana High Court's 2024 directive for complete overhaul of forensic laboratories highlighted systemic infrastructure failures including inadequate physical space, lack of proper

evidence receiving sections, and absence of barcoded tracking systems. Click or tap here to enter text.

Equipment obsolescence and technological limitations affect approximately 50.4% of cases in Indian forensic laboratories. Many laboratories continue operating with outdated equipment purchased decades ago, lacking access to modern analytical instruments that have become standard in international forensic facilities. Click or tap here to enter text.

### **Manpower Shortage and Training Deficits**

The critical manpower shortage affecting approximately 40% of sanctioned positions represents perhaps the most severe constraint on forensic laboratory operations in India. According to government data, of the total sanctioned staff strength of approximately 4,500 personnel, only about 3,000 are trained experts. This translates to one forensic scientist for every 460,000 citizens in India. Click or tap here to enter text.

“Training deficiencies exacerbate manpower challenges, with insufficient forensic science education institutions, lack of specialized training programs, and inadequate exposure to international best practices. The National Forensic Infrastructure Enhancement Scheme's component for establishing nine off-campus of the National Forensic Sciences University represents a strategic intervention to address the manpower shortage. Click or tap here to enter text.

### **Case Backlog and Pendency Crisis**

The mounting case backlog affecting Indian forensic science laboratories constitutes a critical threat to timely justice delivery, with pendency ranging from 18,000 to 62,000 cases per major laboratory facility. Delhi's Forensic Science Laboratory at Rohini faces over 22,000 pending forensic reports, with cyber forensics division alone having over 7,000 pending cases. Kerala's three forensic science laboratories collectively grapple with 62,558 unresolved cases as of March 2024. Haryana's FSL at Karnal struggles with a backlog of 18,559 cases despite clearing 21,620 cases in 2024. Click or tap here to enter text.

### **Quality Management System Deficiencies**

The comprehensive implementation of quality management systems remains a critical gap in Indian forensic laboratories. The Forensic Science India Report documented that forensic science laboratories lack quality management systems and view quality management only as a requirement for accreditation rather than integral to routine casework. Key deficiencies include absence of comprehensive quality manuals, incomplete working procedure manuals, lack of participation in proficiency testing programs, failure to calculate error rates, absence of systematic technical review, inadequate internal audit programs, and insufficient method validation protocols.

### **Recommendations for Strengthening Forensic Standardization and Accreditation**

#### **Immediate Priority Actions**

The establishment of a Forensic Science Regulator for India with statutory authority constitutes the most critical immediate action necessary to drive systemic quality improvement. This regulatory body should possess powers to set mandatory quality standards, develop and enforce

codes of practice, conduct inspections and assess compliance, investigate quality failures, maintain a register of accredited laboratories, and influence judicial admissibility standards. Click or tap here to enter text.

Mandatory accreditation requirements should be phased in progressively, beginning with high-risk forensic disciplines including DNA analysis, toxicology, and forensic biology. Central Forensic Science Laboratories should be required to achieve accreditation within two years, State Forensic Science Laboratories within three years, and Regional Forensic Science Laboratories within five years. Click or tap here to enter text.

Judicial linkage of forensic evidence admissibility to laboratory accreditation status would create powerful incentives for quality compliance. Courts should give enhanced weight to evidence from accredited laboratories operating under ISO/IEC 17025:2017 and ISO 21043 standards.

### **Institutional and Infrastructure Development**

The National Forensic Infrastructure Enhancement Scheme's implementation must prioritize quality infrastructure alongside capacity expansion. New laboratories should be designed from inception with accreditation requirements embedded including adequate space allocation, environmental controls, modern analytical instrumentation, secure evidence management systems, and information technology infrastructure. Click or tap here to enter text.

Public-private partnerships could supplement government forensic capacity, with accredited private laboratories providing forensic services under regulatory oversight. India's emerging private forensic laboratories such as Truth Labs, already NABL accredited under ISO/IEC 17025:2017, demonstrate the feasibility of this model. Click or tap here to enter text.

### **Quality Management System Implementation**

Comprehensive quality management system implementation requires laboratories to develop laboratory-specific quality manuals, working procedure manuals for each forensic discipline, standard operating procedures covering all operational aspects, proficiency testing programs with minimum two external tests per analyst annually, internal audit schedules, management review processes, and method validation protocols. Click or tap here to enter text.

Technical review of casework before report release should be mandatory, conducted by qualified reviewers verifying data interpretation, methodology appropriateness, and conclusion support. Proficiency testing participation must become routine for all forensic personnel conducting casework. Click or tap here to enter text.

### **Capacity Building and Training**

The National Forensic Sciences University and its planned off-campus should integrate quality management, accreditation requirements, and international standards throughout forensic science curricula. Continuing professional development programs should be mandatory for all forensic personnel. Quality manager positions should be established in all forensic laboratories, with qualified personnel responsible for quality system development and maintenance. Click or tap here to enter text.

### Financial and Resource Mobilization

“Substantially increased budgetary allocations for forensic infrastructure, estimated at ₹5,000-7,000 crore over five years, are necessary to achieve universal accreditation across India's forensic laboratory network. A dedicated Forensic Science Development Fund could provide sustained financing independent of annual budgetary cycles. Click or tap here to enter text.

### Conclusion

Forensic science stands at the intersection of scientific inquiry and legal adjudication, wielding profound influence over liberty, justice, and societal safety. India's forensic science infrastructure, while extensive with 697 facilities, faces critical quality assurance deficits that undermine the evidentiary value of forensic outputs. This research has documented the substantial gap between India's current forensic practices and international quality standards, revealing that only 6-8% of Indian forensic laboratories have achieved NABL accreditation compared to 88% in the United States and 95% in the United Kingdom. Click or tap here to enter text.

The challenges confronting Indian forensic laboratories—infrastructure inadequacy, critical manpower shortages affecting 40% of positions, massive case backlogs exceeding 60,000 pending cases, quality management system deficiencies, technological obsolescence, insufficient training, lack of standardization, and chronic funding constraints—collectively threaten the capacity of forensic science to fulfill its essential role in criminal justice. Click or tap here to enter text.

The path forward necessitates transformative reforms rather than incremental adjustments. Establishment of a Forensic Science Regulator with statutory powers represents the most critical institutional innovation required. Progressive implementation of mandatory accreditation creates clear quality benchmarks and timelines for compliance. The National Forensic Infrastructure Enhancement Scheme presents an historic opportunity to simultaneously expand forensic capacity and embed quality systems from inception. Click or tap here to enter text.

Ultimately, the quality of forensic science directly impacts justice outcomes, with reliable forensic evidence serving to convict the guilty, exonerate the innocent, and maintain public confidence in criminal justice institutions. The reforms outlined in this research provide a roadmap for transforming India's forensic infrastructure from its current fragmented state to a world-class system characterized by universal accreditation, rigorous quality management, technical excellence, and unwavering commitment to scientific integrity in service of justice. Click or tap here to enter text.

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