

# A Comprehensive Review of Forensic Medicine: Its Evolution, Scope, Applications, and Future Directions

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## Abstract

*Forensic medicine, derived from the Latin term forensis, meaning “before the forum,” has evolved significantly over the centuries from rudimentary methods of determining the cause of death to a sophisticated and highly specialized medical discipline. Today, it encompasses a wide range of fields, including clinical forensic medicine, forensic pathology, and toxicology, all of which contribute to the investigation of crimes, identification of individuals, and administration of justice. This evolution reflects advancements in science, technology, and legal systems, positioning forensic medicine as a critical link between medicine and law. Today, forensic medicine is an indispensable discipline that plays a crucial role in criminal investigations, civil litigation, and human rights advocacy, drawing upon a wide range of advanced scientific techniques. Modern practices incorporate cutting-edge tools, such as DNA analysis for accurate identification, digital forensics for uncovering electronic evidence, and radiological imaging for non-invasive examinations, greatly enhancing the precision and reliability of legal proceedings. This study explores the historical evolution of forensic medicine, its expanding contemporary scope, and its diverse applications in both criminal and civil justice systems, underscoring its pivotal contribution to truth-seeking and the pursuit of justice in society.*

**Keywords:** Forensic medicine, forensic pathology, DNA analysis, clinical forensic medicine, Locard’s exchange principle

## INTRODUCTION

“Forensic science,” a broad term that encompasses a growing number of scientific and medical subspecialties, refers to fundamental methods for presenting evidence in court that are ideally both legally admissible and scientifically sound [1]. The general phrase “forensic medicine” refers to a wide field of medicine that focuses on the relationship between the legal system and medicine. It includes the skillful use of medical expertise, technology, and analysis to support court cases. The word “forensic” is believed to have come from the Latin word “forensis” which means “of or before the forum” (a forum was a public setting in ancient Rome where conflicts were resolved, among other things) [2].

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Received Date: May 27, 2025

Accepted Date: June 20, 2025

Published Date: November 04, 2025

**Citation:** Tabasum Rouf, Iftikhar Ahmed. A Comprehensive Review of Forensic Medicine: Its Evolution, Scope, Applications, and Future Directions. Research & Reviews: A Journal of Health Profession. 2025; 15(3): 18–28p.

Forensic medicine can be described as the body of scientific knowledge in medicine and paramedicine that is applied to the administration of law. It is often regarded as the science that teaches the application of every branch of medical knowledge for legal purposes [3]. Broadly, forensic medicine is recognized as an interdisciplinary field that integrates medicine and the natural sciences, focusing on the collection, interpretation, and presentation of medical evidence relevant to legal investigations and judicial processes. It addresses medical evidence in both practice and research, and all legal requirements in healthcare are particularly

significant for physicians as they educate, train, and conduct research [4]. Criminalistics, digital and multimedia sciences, engineering sciences, general jurisprudence, odontology (the study of teeth), pathology/biology, physical anthropology, psychiatry and behavioral sciences, questioned documents, and toxicology are the eleven main fields that comprise forensic science, according to the American Academy of Forensic Sciences. The primary responsibility of a forensic pathologist is to conduct autopsies, or post-mortem examinations, on deceased individuals. Therefore, the autopsy is used by doctors to investigate the specifics of that natural death. But in certain cases, including suspicious deaths, a forensic autopsy is carried out to comply with the law. Thus, the evolution of legal frameworks and judicial processes is intimately tied to the history of forensic pathology and autopsy [3].

## **HISTORY AND DEVELOPMENT OF FORENSIC MEDICINE**

Since the beginning of time, religion, superstition, and magic have bound medicine and law together. The priest, who served as a mediator between God and humanity, combined the roles of the doctor and the lawyer. Primitive legal codes, religious beliefs, and social norms were frequently indistinguishable in early civilizations, and laws with a medical focus were frequently found within their framework [1]. It is evidently impossible to pinpoint a single moment in forensic medicine's history as the emergence of the field as a distinct, identifiable scientific field. Without a doubt, it is reasonable to argue that medicine began at the very beginning of human history when a fellow creature experimented with crude kinds of relief after hearing a cry of pain. Similarly, it might be argued that the law's roots lie in the first penalties, which were undoubtedly meted out to peace breakers in the most primitive societies. Forensic medicine can be considered as a whole, only when there are both a recognized legal system and a cohesive body of medical knowledge and opinion. Furthermore, the earliest records date back just roughly 5,000 years, and to learn anything about such topics, some method of recording them has to be developed. Therefore, the records of the early Near Eastern civilizations must be looked at, especially those of the Nile Valley, where there is a sense of the level of knowledge at that early time from the ancient Egyptian inscriptions on stone and later papyri [5].

The histories of anatomy and medicine are entwined with those of autopsies. Observations of animal anatomy provided most of the early anatomical descriptions. This technique dates to Babylonia in the fourth century BC and was common throughout the ancient world. However, only animal autopsies were performed during this period. According to scholars, because the deceased body was considered sacrosanct in ancient times, autopsies were not conducted. Likewise, dissection was prohibited for religious reasons in ancient Asia. Ancient Greek medicine was dominated by humoral beliefs of illness during this time, which inhibited research attempting to link anatomy to illness.

According to the humoral theory, the body is made up of four humors: blood, phlegm, yellow bile, and black bile. It was believed that an imbalance in the body's humoral to elemental ratio was the cause of all illnesses and impairments. For centuries, this medical theory was widely recognized in Europe. As a result, the early applications of forensic medicine were restricted to examining the situation without performing a physical examination. In the ancient world, there were occasional exceptions, though; for example, Alexandria allowed the dissection of the dead. The monarch of Egypt, Ptolemy I Soter (367–282 BC), founded Alexandria's renowned university and library and promoted pathological anatomy. The Greek physician Herophilus of Chalcedon (335–280 BC), who is regarded as the first anatomist, authored a treatise on human anatomy and conducted many autopsies in Alexandria. Erasistratus (310–250 BC) was another contributor at the time who rejected humoral theories and linked organ alterations to illness. A physician named Galen of Pergamum (129–201 AD) conducted anatomic dissections on animals and wrote extensively on human anatomy throughout the Roman Empire. However, humoral philosophy served as the foundation for his writing. Galen's teachings were adopted by most Roman physicians, and his impact persisted into the late Middle Ages [3].

## **THE FIRST MEDICAL–LEGAL PROFESSIONAL**

This was the situation at the time the papyri were composed; however, it is most likely that the rules evolved gradually over a long time and were based on the teachings of Imhotep and his adherents circa

3000 B.C. Imhotep served as King Zozer's Grand Vizier, Chief Justice, and Physician. In addition, he designed the first great pyramid at Sakkara. He was the first notable individual to combine the fields of medicine and law; he may be considered the first medico legal specialist [5].

### **DEVELOPMENT OF PATHOLOGY AND FORENSIC SCIENCE IN THE MIDDLE AGES**

Since autopsies were prohibited during Europe's Dark Ages, pathology did not significantly improve or develop during this time. Frederick II, the Holy Roman Emperor who ruled from 1194 to 1250, passed the first law permitting human dissection in 1231. The prohibition against dissecting a deceased person's body relaxed in the 13th and 14th centuries, and several images depicting autopsies show that dissections were being performed in Italy between 1266 and 1275. The first medico legal autopsies – autopsies conducted to assist in resolving legal issues – were carried out in Europe in 1302 in Bologna.

In Asia, Muslim medical professionals made significant contributions by identifying infectious diseases and advancing the understanding of their progression. One of the earliest physicians performing postmortem autopsies pioneered systematic study of the human body. During the Song Dynasty in China, human dissections were occasionally conducted, with officials collaborating with painters and physicians to examine criminals and document anatomical findings. A detailed manual was later produced, providing comprehensive guidance on body dissection and postmortem inspection techniques, marking an important step in the development of forensic practices. It also provided examples of techniques to employ when looking into forensic concerns like poisoning, decomposition, wounds from different weapons, strangulation, and phoney wounds, as well as strange deaths.

### **DEVELOPMENT OF FORENSIC PATHOLOGY DURING THE RENAISSANCE**

Galen's theories began to fall apart during the Italian Renaissance, leading to significant changes in medical education, medico-legal science, and medicine. Dissections were only allowed on executed criminals until the early modern era. By the 1500s, autopsies had gained widespread acceptance, even among religious authorities. The 16th century marked the emergence of written documentation highlighting the growth of forensic pathology in Europe. During this period, universities began offering formal courses in forensic medicine, and scholarly works in the field were increasingly published. Physicians of the time pioneered the use of anatomical dissection to determine causes of death, laying the foundation for pathological anatomy. By the end of the century, autopsy-based death investigations had become more frequent and were supported by newly established legal frameworks, reflecting the growing integration of science and law. Medical expert testimony was allowed under this first German criminal law. Mandated by judges in situations involving infanticide, hanging, poisoning, murder, wounding, and abortion. These records demonstrate the prominence that forensic pathology has attained within the court system. Due to the knowledge gained by numerous pioneers, European police and judicial authorities started to ask doctors to help solve deadly crimes in the latter half of the sixteenth century. Most major jurisdictions established forensic medicine institutes to enable professionals to carry out detailed investigations. The concept of the autopsy emerged as a pivotal development in medical science, introducing the practice of correlating pathological findings with clinical symptoms.

This approach greatly enhanced the understanding of disease processes and contributed significantly to the advancement of diagnostic methods and medical knowledge. Inspired by this perspective, many physicians began studying the internal changes associated with illnesses in greater detail, leading to significant progress in diagnostic and therapeutic practices. Institutions dedicated to pathology education were established, and detailed visual resources were created to aid in medical training. Post-mortem examinations became a regular practice in hospitals, with their findings increasingly applied to improve clinical decision-making and enhance the overall quality of patient care.

### **MODERN FORENSIC PATHOLOGY**

When Jean Lobstein (1777–1835) was appointed to the Professorship of Pathology at the University of Strasbourg in 1819, pathology was recognized for the first time as a separate scientific field. The discipline of pathology emerged as a medical subspecialty in the latter half of the nineteenth century.

Other relevant forensic science disciplines, including chemistry, physics, biology, and microscopy, also began to emerge around the same period. The founder of toxicology, Mathieu Joseph Bonaventure Orfila (1787–1853), sought to introduce forensic medicine to chemistry. By using chemical analysis of human tissues and fluids, pathologists could identify the presence of alcohol and other drugs in a body, as well as symptoms of medical conditions. Edmond Locard (1877–1966), a criminologist, was a trailblazer in French forensic science. He introduced the principle in forensic science that every contact leaves a trace, a concept that became a cornerstone of criminal investigations. One of his greatest accomplishments was the establishment of the first crime laboratory, which brought together multiple scientific specialties for investigative purposes. The success of this pioneering laboratory inspired the creation of similar facilities across Europe and America. Around this period, pathologists began incorporating the use of microscopes into their work, revolutionizing the study of disease and forensic evidence. Forensic pathology also advanced significantly with the contributions of leading medical professionals who played pivotal roles in shaping investigative practices and establishing modern standards in the field. He persuaded Scotland Yard investigators of the value of having a medical forensic expert present at crime scenes [3].

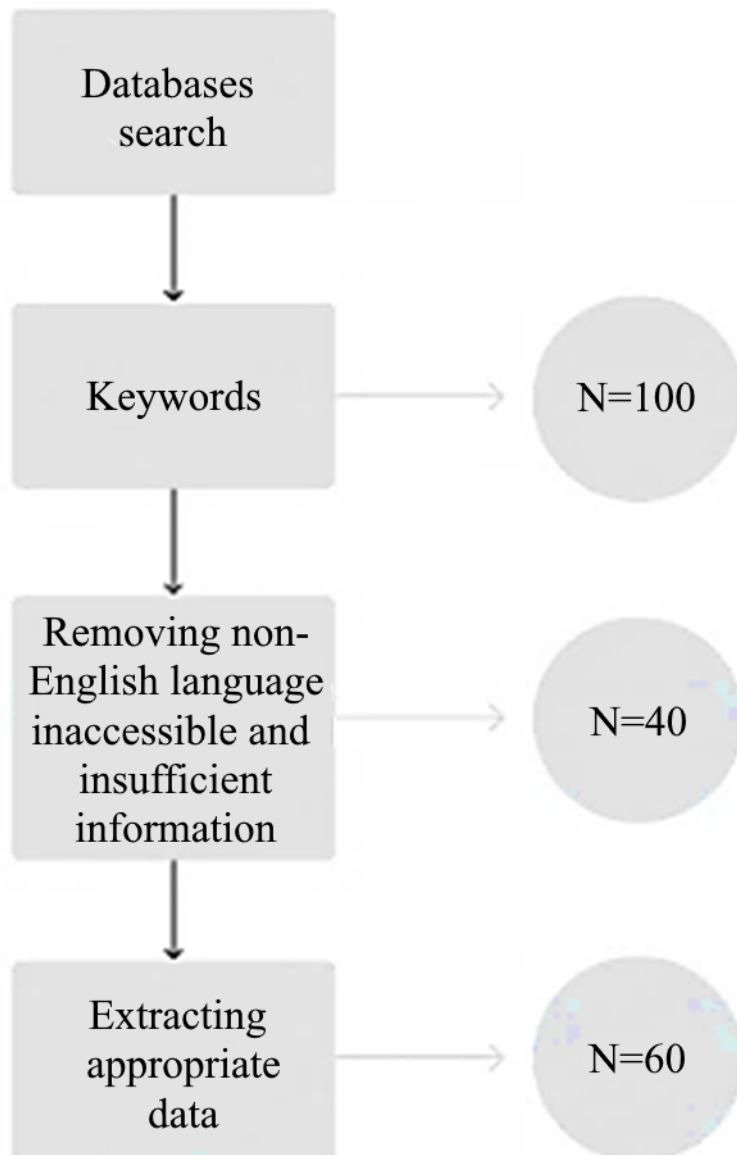
### **THE STATE AND APPLICATION OF FORENSIC MEDICINE TODAY**

Even though forensic medicine has a long history, with studies dating back to ancient civilizations, it remains one of the least understood and least recognized medical specialties. Compared to other specialties, both financially and otherwise, forensic medicine – particularly forensic pathology – is a relatively uncommon career choice. Many medical undergraduates perceive forensic medicine as gruesome, removed from the clinical setting, involving long and unpredictable work hours, and offering little job appreciation. The number of criminal and civil investigations and cases worldwide that utilize or require forensic medical expertise each year remains unknown, with even less data available for individual nations. Although the WHO's World Health Statistics provides information on several forensic-related health topics (such as substance abuse, violence, and traffic injuries), there is a notable lack of comprehensive data. Public awareness of forensic medicine's role in society has been increasing, largely due to its idealized portrayal in the media. However, the demand for superior forensic services is also growing. Despite the critical role forensic medical expert opinions play in the legal system, the techniques employed by forensic professionals are not always evidence-based or supported by standardized procedures. Additionally, forensic physicians must consider various non-medical factors, particularly in cultures or environments where autopsies are viewed unfavorably due to social or religious reasons. This discrepancy poses challenges in evaluating and comparing the effectiveness and outcomes of forensic medical services both across countries and within centers in the same nation.

Several initiatives have been undertaken to harmonize regulations in forensic medicine, particularly concerning forensic autopsies. One notable example is the 1999 European Harmonization of Medico-legal Autopsy Rules initiative, which was revised in 2014. Expert opinions in forensic medicine are provided either orally or in writing. Typically, a written report includes the expert's opinion on the issues involved in the case evaluation, serving as the primary component of the forensic medical practitioner's involvement in the case. Written reports are the main output of forensic medical practice, in contrast to clinical or hospital records, which are secondary to the medical treatment performed by clinicians (and are occasionally regarded as "a necessary evil"). Additionally, written reports act as the primary channel of communication between forensic medical professionals and attorneys, who are their clients. Ambroise Paré authored the first published work on the techniques for creating medico-legal reports in sixteenth-century France. This work was part of several volumes on forensic medicine. As forensic medicine developed differently across regions and through varied methods, the scope and quality of reports provided by forensic medical professionals also vary. A literature search using keywords, such as "forensic medical report," "forensic medicine report," "clinical forensic report," and "autopsy report," revealed numerous examples of forensic reports. However, no established standards exist for creating a uniform and acceptable forensic medical report (Figure 1).

## METHODOLOGY

- Google Scholar.
- Scopus.
- PubMed.
- ScienceDirect.
- Forensic Medicine.
- Forensic Pathology.
- Clinical Forensic medicine.
- Medical jurisprudence.
- Medico–legal studies.



**Figure 1.** Flowchart of the study protocol.

## SCOPE OF FORENSIC MEDICINE

### Clinical Forensic Medicine

This section is concerned with “Living issues” that refers to medical concerns with a forensic or legal component that affect living individuals. These include:

- a. Incidents of males (sodomy) or females (rape) being sexually assaulted.
- b. Instances of calculating injuries and disability percentages for victims of physical attacks, whether due to criminal activity or errors in calculating the proportion of compensation.
- c. Determining age in accordance with judicial authorities' orders, at the request of any interested party, or in situations permitted by law.
- d. Evaluating a person's mental health to prosecute them, manage their property, or hold them accountable for crimes is considered an essential part of the forensic physician's work. In some countries, these medical matters fall within the forensic physician's purview, while in others, they are assigned by mandate to specialists in other medical specialties, hospitals affiliated with the Ministry of Health, or areas predetermined by judicial bodies.

### **Forensic Pathology**

This branch deals with autopsy and post-mortem examination, determination of cause and manner of death and role of forensic pathologists in death investigation.

The purpose of the autopsy is to establish both general criminal responsibility and personal rights, making it a legally mandated examination. The doctor to whom such a request is submitted is required to perform the autopsy, particularly in the following situations:

1. Deaths caused by suspected accidents and acts of violence.
2. Deaths from alcohol, drugs, and poisoning.
3. Maintaining the health of superficial harm and connecting it to deeper damage.
4. Mortal organic insult appointment.

In the event of several injuries, confirm the types of injuries:

1. Assessing the deceased's structural resistance, health, and the extent to which each of these factors contributed to his demise.
2. Deaths brought on by medical mistakes and procedures like surgery and abortion.
3. Unexpected deaths.
4. Prison deaths.

### **Forensic Toxicology**

Although there are some parallels between forensic toxicology and clinical toxicology, there are also significant variances. Although the analytical techniques used in the two disciplines are frequently similar, forensic toxicology is more focused on chemical substances and legal issues, whereas clinical toxicology focuses more on patient treatment [6].

The field of study that deals with analyzing evidence gathered during a crime scene investigation is called forensic science. This branch focuses on determining the cause of death by examining the manner of death. A variety of analytical techniques are used in modern forensic toxicology, including capillary electrophoresis, laser diode thermal desorption-tandem mass spectrometry (LDTD-MS-MS), hyphenated liquid chromatographic techniques, silica-gel chromatographic techniques, ultra-high-performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS), DNA typing, and capillary electrophoresis. These methods can identify pesticides, medications, natural products, industrial chemicals, metals, and pollutants as part of forensic investigations. Toxicological analysis can be performed on various samples obtained from the subjects of the study. Useful specimens include blood, urine, hair, nails, bile, stomach contents, liver, and brain tissue. Through the analysis of biological samples to identify and measure harmful compounds, forensic toxicologists are essential to the investigation of poisoning and overdose cases. The need for contemporary analytical methods used in forensic toxicology to resolve conflicts is steadily rising [7].

### **Forensic Genetics**

Forensic genetics has evolved gradually through long-term societal practice, much like other disciplines, and includes DNA analysis, profiling, and paternity and kinship testing. Human blood type

was first used for identification after Landsteiner discovered the ABO blood groups in 1900, marking the entry of forensic genetics into the scientific era. The foundation for contemporary forensic science was established in 1910 when French criminologist, Edmond Locard proposed Locard's exchange principle, stating that "every contact leaves a trace." The field of forensic genetics was further developed based on the gene theory put forward by Thomas Hunt Morgan in 1926. The discovery of the double-helical structure of DNA in 1953 enabled molecular-level forensic genetics research. A key component of forensic genetics is the use of genetic markers, which are readily recognized phenotypes and genotypes. These markers provide a new method for addressing challenging cases involving complex kinship identification and resolving mixtures. Genetic markers are characterized by strong polymorphisms, codominant expression, and ease of observation and recording. The application of genetic markers has advanced progressively alongside developments in the field of genetics. The creation of genetic markers has undergone four main stages, encompassing morphological, cytological, biochemical, and molecular markers. This section provides an overview of the development and use of molecular markers in forensic science [8].

## **APPLICATIONS FOR FORENSIC MEDICINE**

### **Importance of Forensic Medicine in the Justice System**

The scope, functions, and responsibilities of forensic medical experts differ greatly between nations and legal systems, even though they all use medical knowledge, techniques, and technology for legal objectives. Forensic pathology, which mostly comprises of autopsies performed in cases of questionable or unreported deaths, is sometimes referred to as forensic medicine in the United States [9–14]. However, forensic medicine has a much wider scope in the UK and other European nations, including investigations into sexual assault, medical malpractice, police tactics, and other situations where the law and medicine interact. In contrast to clinical medicine, which produces determinable outcomes that are studied prospectively, forensic medical work is retroactive in nature, frequently producing probabilistic conclusions that cannot be evaluated against a gold standard. This makes such activities even more difficult. Since experience-based practice makes up most of the forensic medicine, the role of evidence-based practice – a crucial aspect of clinical medicine – is also somewhat less clear in this field [15].

### **Crime Investigation**

Many nations currently employ various crime investigation techniques, each with its own benefits and drawbacks. Consequently, discussions about improving criminal investigation systems are ongoing worldwide. The initial investigation at the scene of an incident is referred to as an inquest – a legal investigation into the cause of death. Upon receiving information about a human body discovered under unusual or suspicious circumstances, the relevant authority visits the scene, investigates and prepares an inquest report outlining the apparent cause and circumstances of death. If an autopsy is necessary, the body is delivered to the nearest authorized autopsy center. There are several significant inquest systems, including the police inquest, magistrate inquest, coroner inquest, medical examiner inquest, and jury inquest [16–19]. In India, only police and magistrate inquests are conducted under sections 174 and 176 of the Cr.P.C., respectively. These public officials are generally laypeople with limited training in law and forensic science [16]. In India, crime scene investigations and autopsies are conducted by separate agencies, with minimal cooperation between them, as they operate independently. In contrast, in the United States, coroners are elected officials who may or may not have legal or medical qualifications. During British rule, India also had a coroner system, which was eventually abolished in Mumbai on July 29, 1999, and replaced by the police and magistrate system after independence. Forensic physicians play a crucial role in establishing the material and moral foundations of crimes affecting an individual's physical integrity through forensic medical reports. These reports serve as tools to inform judges about evaluating the facts that constitute an offence.

Additionally, the role of the forensic physician in cases of death and injury highlights how forensic medicine addresses crimes related to human safety. Death is not simply characterized as a violent end to life but as the cessation of essential bodily functions, including breathing, heartbeat (blood

circulation), and neurological activity. Before issuing a death certificate, a doctor conducts a death examination. After confirming death, the physician determines its cause, which is often natural (due to illness or sudden cardiac arrest) but may also result from an accident, suicide, or criminal act such as murder. In cases of intentional murder, willful killing is defined in Article 254 of the Penal Code as “the willful taking of a person’s life.” The principle requires that the victim must have been alive at the time of the crime; otherwise, the act is considered corpse mutilation. Since suicide is not punishable by law, the crime is presumed to involve another individual, regardless of whether the victim was alive at the time of the act. Forensic pathologists play a critical role in determining whether a death resulted from a criminal act or suicide [20].

### **Public Health and Safety**

Forensic medicine has traditionally focused on the human environment, serving as a background for certain court proceedings or as a potential source of pathological agents [21, 22]. In the twenty-first century, a new definition may be needed, of the term “environment.” This new type of human environment could be described as the total space encompassing all human interactions and actions – a comprehensive space where virtual and physical sub-spaces frequently coexist. The virtual world was created by human technology, following the establishment of the physical environment by nature.

Therefore, if shared living spaces in the twenty-first century are both physical and virtual, the reality is techno–environmental. Clinical medicine is also evolving its perspective on the environment. Using an OMICS approach, it is now examining the environment, which is defined as the dynamic fusion of personal, social, and natural environments [21, 23]. Millions of people unknowingly traverse several physical and virtual areas every day, one by one. Any of these encounters may have implications for justice and, consequently, for forensic medicine or criminology. Perhaps the first virtual environment was the Internet [21, 24], and thanks to its development, it has now become a workspace, a game space, a social space, and, ultimately, a crime space [21, 25]. The COVID-19 pandemic has also led to a significant expansion of virtual spaces for social, medical, and professional purposes [21, 26].

“In the meantime, artificial intelligence (AI), with its basic framework comprising an initial input, a potentially powerful computation, and a final output, has created new horizons and forms for the virtual environment [21, 27].” When discussing AI, the virtual world frequently appears to be a “black box” [21, 28], raising serious concerns about the limits of human understanding of AI. An artificial intelligence (AI)-based virtual environment primarily represents a very fast and compressed input-output reality, with significant intermediary steps sacrificed for external human comprehension. The physical world, on the other hand, is a progressive reality with factual chains composed of numerous visible or intelligible intermediary steps.

As a result, physical and virtual environments differ greatly; the former is familiar to humans, while the latter is novel and uncharted. The AI revolution has made it abundantly evident that the virtual world has its own set of laws that have not yet been identified, established, or adhered to. Both new virtual and old physical laws will be used in the 21st-century techno–environmental world, but some of the old physical rules will likely need to be updated or reimaged. As a result, the 21st century must also accommodate a new technical approach to the natural environment [21, 29]. The hierarchy of rules, laws, and crimes is clear-cut. All struggle every day as humans to preserve the environment [21, 30, 31]. Examples of communal adversaries that should be combated immediately include plastic pollution, toxic gases, chemical residues, noise pollution, and wild deforestation [21, 32–35]. Like any other human endeavor, this battle has a legal face as well – the face of the so-called green crimes. In its most basic form, green crimes are the result of disregard for environmental regulations. Because of the existence of green crimes, our society urgently needs both environmental forensic medicine (EFM) and environmental justice (EJ) [21].

### **DISCUSSION**

Forensic medicine, a critical intersection of medical science and legal systems, has evolved significantly since its origins in ancient Rome, where “forensic” referred to public legal proceedings.

Despite advancements, the field faces pressing challenges. In India, the lack of standardized practices, inadequate legal frameworks for evidence admissibility, and limited resources hinder the effective use of forensic evidence. Additionally, forensic facilities require upgrades, and the number of trained experts must be increased to meet growing demands. Ethical and privacy concerns posed by databases and smart technology also require attention, alongside the need for rigorous training and certification programs.

Future directions emphasize standardizing forensic practices through national guidelines, investing in research and development to innovate technologies, and fostering collaboration between government and private sectors. Specialized units in health, environment, defense, and intelligence now play vital roles, reflecting the growing scope of forensic medicine. Addressing these challenges can enhance the accuracy and fairness of forensic investigations, bolster public trust, and position forensic medicine as a cornerstone of modern justice systems.

## CONCLUSIONS

The lack of uniform terminology and standardized practices in forensic medicine creates significant challenges in assessing its development and performance as a discipline. Variations in practices both within and across countries hinder the establishment of universally accepted codes of conduct and guidelines. Forensic medicine often relies on experience-based methods passed down through generations, leading to inconsistencies. A standardized taxonomy could address these issues, with “forensic medicine” serving as an umbrella term and specific branches, such as forensic pathology and clinical forensic medicine, denoting specialized services. The globalization of forensic services further underscores the need for uniform standards to ensure cross-border cooperation and scrutiny. The “CSI-effect,” driven by media portrayals of infallible forensic science, has created unrealistic expectations of expert opinions, which are inherently limited by the methods and data used. Evidence-based practices, though underutilized, are crucial to enhancing the validity and reliability of expert opinions, reducing bias, and ensuring sound methodology. Expert opinions must be clearly and comprehensively presented to facilitate understanding by legal practitioners, as poorly formulated reports can mislead judicial decisions. Without standardization, quality assessment and comparison of forensic medical reports remain challenging for judicial factfinders.

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