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FORENSIC SCIENCE AND CRIMINAL JUSTICE SYSTEM: A COMPREHENSIVE STUDY

Mahesh Singh , Aishwarya Suresh

Student LLM in Business & Corporate Law, Reva University, Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka - 560 064
theblackingrey@gmail.com
Student LLM in Business & Corporate Law, Reva University, Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bengaluru, Karnataka - 560 064
aishwarya.aashes@gmail.com

Abstract

Forensic science is a multidisciplinary field that uses scientific methods to investigate and solve crimes. It involves the collection, analysis, and interpretation of physical evidence from crime scenes, such as fingerprints, DNA samples, fibers, and firearms. In cases where the bodies are severely decomposed or damaged, forensic experts can use various techniques to extract DNA from different sources, including bone marrow, teeth, and hair. Forensic science can also help identify the cause of death, by giving an evidentiary value to a piece of evidence.

Forensic science is important in the criminal legal system because it provides evidence backed by scientific explanation that can be used to support or refute a hypothesis about a criminal offence. While the forensic report can help with the conviction of the real culprit, it can also help in exonerating an innocent wrongfully accused of a crime.

In India, the use of forensic science for victim identification is becoming more widespread, with forensic experts being trained to handle the latest technology and techniques. However, incorrect forensic reports due to negligence in investigation are not uncommon. According to NCRB, lack of evidence is a primary factor which has resulted in up to 35.5% of abysmal convictions. Such negligence occurs due to various reasons including inadequate training, lack of resources, pressure from superiors or political influences, and corruption.

Inadequacy in forensic labs and training also result in an excess number of impending cases which, in turn, results in delayed justice.

This paper aims to critically analyze the irresponsible behaviour, negligence and flouting of legal procedure on part of the executive authorities by emphasizing the after-math and repercussions of improper, negligent, incorrect or delayed reporting to the forensics.

Key words: *Forensics, Evidentiary value, Negligence, Delay and Repercussions.*

1) Introduction

Forensic Science is a field of study that involves the application of scientific techniques to investigate and solve criminal and civil cases. It involves the collection, analysis, and interpretation of physical evidence such as blood, hair, fibers, and fingerprints, among others. The primary aim of Forensic Science is to provide reliable, valid, and unbiased evidence that can be used in legal proceedings to establish the guilt or innocence of an accused person. The field has numerous sub-disciplines such as forensic pathology, forensic toxicology, forensic anthropology, and forensic psychology, among others. Each sub-discipline is specialized in examining specific types of evidence related to a crime, such as examining the cause of death, the presence of drugs or poisons, or the psychological state of a suspect.

Forensic Science has a significant role in the criminal justice system as it can provide crucial evidence that can help to solve cases and bring justice to victims. It has played a crucial role in numerous high-profile international cases, such as the O.J. Simpson murder trial (1995)[1], the JonBenét Ramsey murder case (1996)[2], and the Casey Anthony trial and Indian cases such as the Naina Sahni Murder Case (1995)[3], the Jessica Lal Murder Case (1999)[4] and the Nitish Katara Murder Case (2002)[5].

Additionally, Forensic Science has also been instrumental in identifying victims of natural disasters, terrorist attacks, and war. The use of Forensic Science has evolved over the years, and the techniques used have become more advanced and accurate. However, the field faces challenges

[1] Laura Shackel, "Case File: The OJ Simpson Trial" The People of the State of California v. Orenthal James Simpson, Judgement date Oct 3, 1995, Forensic Science Society, Aug 13, 2021, https://forensicsciencesociety.com/thedrip/case-file-the-oj-simpson-trial
[2] JonBenét Ramsey murder case, Crime Museum, Crime Library, Cold Cases, https://www.crimemuseum.org/crime-library/cold-cases/jonbenet-ramsey/
[3] State v. Sushil Sharma, 2007 CriLJ 4008
[4] Sidhartha Vashisht @ Manu Sharma v. State (NCT Of Delhi),Crl.A.no. 179 of 2007
[5] Vishal Yadav v. State Of UP, Crl.A.Nos.741, 910/2008 & 145/2012

such as a lack of resources, limited technology, and human error, which can affect the accuracy of the evidence presented in court. Therefore, it is essential to continue to research and develop new techniques and technologies in Forensic Science to ensure that it remains a reliable and valuable tool in the criminal justice system.

2) Importance of Forensic Science in Criminal Justice System

Forensic Science plays a vital role in the criminal justice system, as it helps to solve crimes and ensure justice is served for victims. Forensic evidence, which includes DNA analysis, fingerprint analysis, and ballistics analysis, among others, is crucial in linking suspects to crime scenes, identifying perpetrators, and exonerating innocent individuals. By providing evidence that is admissible in court, Forensic Science helps to ensure that the guilty are held accountable for their actions and that the innocent are not wrongfully convicted. The use of Forensic Science has also been instrumental in solving cold cases, identifying serial killers, and helping to exonerate individuals who have been wrongfully convicted.

Forensic Science is essential in providing objective and impartial evidence that can be used in legal proceedings, and it has become increasingly important in modern criminal investigations. The use of Forensic Science can often be the difference between a successful prosecution and an unsuccessful one. As such, the forensic evidence gathered in a criminal case can often have a significant impact on the outcome of the trial. Furthermore, Forensic Science can be used not only to investigate crime but also to prevent it from occurring in the first place. For example, ballistics analysis can be used to trace the origins of illegal firearms and identify potential suspects, while forensic accounting can be used to detect financial fraud and prevent white-collar crime.

3) The Role of Forensics in Victim Identification

Forensic science can play a critical role in identifying the victim in cases where a victim's identity is unknown, and providing crucial evidence that can lead to the successful prosecution of the perpetrator. Techniques such as DNA profiling, fingerprint analysis, and dental records can all be used to positively identify a victim, even in cases where the remains are badly decomposed or burned.

Forensic science can also play a key role in establishing the circumstances surrounding a victim's death. By analyzing evidence such as blood spatter, gunshot residue, and the positioning of a body, forensic experts can often determine the cause of death and help to reconstruct the events leading up to it.

3.1) Techniques Used for Victim Identification

3.1.a) DNA Profiling

DNA profiling is one of the most commonly used techniques for victim identification in Forensic Science. It involves the analysis of DNA samples taken from a crime scene, such as blood, semen, or hair, and comparing it to DNA samples taken from potential victims or suspects. The analysis of DNA profiles can help to determine whether a victim was present at a crime scene or whether a suspect was involved in a crime.

The process of DNA profiling involves extracting DNA from the sample and then analyzing it using various techniques, such as Polymerase Chain Reaction (PCR) or Restriction Fragment Length Polymorphism (RFLP) analysis. PCR is a commonly used technique that involves amplifying specific regions of the DNA to create millions of copies, which can then be analyzed using gel electrophoresis.[6] RFLP analysis involves cutting the DNA into smaller fragments using restriction enzymes and then analyzing the resulting fragments using gel electrophoresis.[7]

Limitations

Despite its high evidentiary value, DNA profiling is not without its limitations and challenges. One of the biggest challenges is obtaining high-quality DNA samples from crime scenes, as DNA can be easily degraded by exposure to heat, moisture, or bacteria.[8] Another challenge is the potential for contamination of DNA samples, which can lead to false positives or false negatives.

[6] MaryAnn De Pietro,"What to know about PCR tests", *Medical News Today*, Feb 27, 2022, available at https://www.medicalnewstoday.com/articles/what-is-pcr-test (Mar 2, 2023)
[7] Shurjo K. Sen, "Restriction Fragment Length Polymorphism (RFLP)", *NIH*, Mar 10, 2023, available at https://www.genome.gov/genetics-glossary/Restriction-Fragment-Length-Polymorphism (Mar 2, 2023)
[8] Bernadette Mckinney, "At What Temperature does DNA Degenerate?" *Problem Solver X*, May 30, 2022, available at https://problemsolverx.com/at-what-temp-does-dna-degrade/ (Mar 3, 2023)

Additionally, there are ethical and privacy concerns surrounding the use of DNA profiles, such as the potential for discrimination based on genetic information.

3.1.b) Fingerprint Analysis

Fingerprint analysis is a technique that has been used for over a century in Forensic Science for victim identification and criminal investigations. The analysis of fingerprints involves comparing the unique ridge patterns and other characteristics of a fingerprint found at a crime scene with those in a database of known fingerprints. The process of fingerprint analysis involves first collecting the fingerprint from the crime scene, typically using a powder or other material to make the ridges visible. Once the fingerprint has been collected, it is analyzed using various techniques, such as visual inspection, computer software, or automated fingerprint identification systems (AFIS).[9]

Fingerprint analysis has several advantages over other techniques for victim identification, including its high level of accuracy and reliability. Fingerprint patterns are unique to each individual and remain relatively unchanged throughout a person's life, making them an excellent tool for identifying suspects or victims. Moreover, fingerprints can be easily collected from a surface such as glass, metal, or paper, making them a valuable tool in an investigation.

Limitations

While fingerprint analysis plays a vital role in forensic science it also has its limitations and challenges. One of the biggest challenges is the potential for errors or false positives in the analysis process. While fingerprints are unique to each individual, there is still a possibility of two people having similar or identical patterns, leading to a misidentification.[10] Bruce Basden from North Carolina had to serve 13 months in prison before it was found out that there was a mistake in the fingerprint analysis.[11] Moreover, the quality of the fingerprint sample can also impact the accuracy of the analysis. If the samples are smudged or partial it is difficult to analyze them.

[9] "How to Analyze Fingerprints", *WikiHow*, Dec 02, 2022, available at https://www.wikihow.com/Analyze-Fingerprints (Mar 3, 2023)
[10] Clive Thompson, "The Myth of Fingerprints", *Smithsonian Magazine*, Apr 2019, available at https://www.smithsonianmag.com/science-nature/myth-fingerprints-180971640/ (Mar 3, 2023)
[11] *Supra*

3.1.c) Dental Records

The process of using dental records for victim identification involves comparing the dental records of a potential victim or suspect with dental evidence found at a crime scene. This evidence can include teeth, dentures, or even bite marks left at the scene of a crime. Dental records can include x-rays, photographs, and other documentation of the person's dental history. Dental records are particularly useful in cases where fingerprints or DNA are not available.

Dental records provide a unique and detailed record of a person's dental history, making it possible to identify a person based on their teeth. Additionally, dental records can provide information about a person's physical characteristics which can be very useful in investigations.[12]

Limitations

One of the biggest challenges is obtaining accurate dental records from potential victims or suspects. Many people may not have dental records or such records may not be easily accessible, particularly if the person is from a different country or region. Moreover, dental records can be difficult to compare accurately, especially if the dental evidence at the crime scene is damaged or incomplete.

3.1.d) Facial Reconstruction

Facial reconstruction involves creating a three-dimensional model of a person's face based on skeletal remains or other evidence found at a crime scene. The goal of facial reconstruction is to create a likeness of the person that can be used to aid in the identification of the victim or suspect. The process of facial reconstruction involves first obtaining a skull or other skeletal remains from the crime scene. The skull is then cleaned and examined to determine the person's physical characteristics. This information is used to create a clay or plastic model of the skull, which is then used to reconstruct the face.

Facial reconstruction can be done in several ways, including traditional forensic facial reconstruction, where a forensic artist uses clay or other materials to create a likeness of the

[12] Joseph W. Evans, "Understanding the Clinician's Role in Forensic Dentistry", *Decisions in Dentistry*, July 11, 2018, available at https://decisionsindentistry.com/article/understanding-the-clinicians-role-in-forensic-dentistry/ (Mar 3, 2023)

person's face, or computerized facial reconstruction, where a computer program is used to create a three-dimensional model of the person's face based on the skull or other evidence. [13]

Limitations

Facial reconstruction can be a challenging technique, as it requires a high level of skill and expertise to create an accurate likeness of the person's face. Moreover, facial reconstruction is not always a reliable or accurate technique. Moreover facial reconstruction can be subjective influenced by the biases and assumptions of the artist or computer program used. Additionally, the accuracy of the technique can be impacted by factors such as the condition of the skeletal remains such as insufficient tissue thickness, and the quality of the data used to create the reconstruction.[14]

4) The role of Forensic Science in Criminal Justice System

Forensic science is the application of scientific principles and techniques to the investigation of crimes and the legal system, and it has a significant impact on every stage of the criminal justice process. From the initial investigation of a crime to the final verdict, forensic science plays a key role in ensuring that justice is served and that the guilty are held accountable.

One of the most important ways that forensic science contributes to the criminal justice system is through the collection and analysis of physical evidence. Forensic science can also be used to exonerate individuals who have been wrongly accused or convicted of crimes. By analyzing physical evidence such as DNA or fingerprints, forensic experts can often provide conclusive proof of innocence, helping to correct wrongful convictions and prevent miscarriages of justice.

Forensic science has revolutionized the criminal justice system in the investigation of cold cases. Cold cases are unsolved crimes that have gone dormant for months, years, or even decades. By applying advanced forensic techniques to old evidence, such as DNA analysis and fingerprint analysis, forensic experts can often provide new leads and help to solve cases that may have otherwise remained unsolved.

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[13] Vincent M. Phillips, Skeletal Remains Identification by Facial Reconstruction, Volume 3, Forensic Science Communications, Jan 2001

[14] Bernita Pouros V, "How Reliable Is Facial Reconstruction?", *Times Mojo*, July 7, 2022, available at https://www.timesmojo.com/how-reliable-is-facial-reconstruction/ (Mar 3, 2023)

4.1) Techniques Used for Criminal Investigations

4.1.a) Ballistics

Ballistics is a branch of forensic science that deals with the study of firearms, ammunition, and the trajectory of projectiles. Ballistic experts use a variety of techniques to analyze firearms-related evidence, including bullet and cartridge case examination, firearm identification, and trajectory analysis.

One of the primary techniques used in ballistics analysis is bullet and cartridge case examination. This involves analyzing bullets and cartridge cases recovered from a crime scene to determine important information such as the caliber and type of firearm used, the number of shots fired, and the distance between the firearm and the target.

Firearm identification involves analyzing the unique characteristics of a firearm, such as the rifling pattern on the inside of the barrel, to determine if a specific firearm was used in a crime. This type of analysis can be critical in linking a suspect to a crime scene, and can provide key evidence in criminal trials.

Trajectory analysis involves examining the path of a projectile as it travels from the firearm to the target, and can provide important information such as the location of the shooter and the angle at which the shot was fired. By analyzing this information, forensic experts can help to reconstruct the events of a crime and provide law enforcement officials with key leads to follow up on.[15]

4.1.b) Blood Spatter Analysis

Blood spatter analysis is the study of bloodstains at a crime scene. It can provide information such as the position of the victim and the perpetrator, the nature of the weapon used, and the number of blows inflicted. By analyzing blood spatter patterns, forensic experts can help to reconstruct the events of a crime and provide leads to law enforcement officials.

Blood spatter analysis involves examination of the shape and size of the bloodstains that can help to determine the angle and force of the blow that caused the spatter. The distribution of bloodstains

[15] "Forensic Ballistics – Reconstructing a Crime using Bullets", *Incognito Forensics Foundation*, available at https://ifflab.org/the-application-of-forensic-ballistics-in-criminal-investigations/ (Mar 4, 2023)

at the crime scene is also examined which helps to determine the sequence of events that took place.

Forensic analysts use specialized equipment such as UV light and luminol, which can detect bloodstains that are not visible to the naked eye. It helps in cases where a perpetrator has attempted to clean up a crime scene or where bloodstains are difficult to detect.[16]

4.1.c) Fiber Analysis

Fiber analysis is a technique used in forensic science that helps to identify and link evidence to a specific individual or location. Fibers can be found in a wide range of materials including clothing, carpeting etc, and can provide information about a crime scene or suspect. By analyzing the fibers present at a crime scene or on a suspect's clothing, forensic experts can help to reconstruct the events of a crime and provide important leads to law enforcement officials.

Forensic analysts compare fibers found at the crime scene with fibers found on a suspect's clothing or in their environment. This can help to link a suspect to a crime scene, or identify a suspect who may have been in contact with the victim.[17]

Fiber analysis also involves the use of microscopy and spectroscopy to identify the chemical and physical characteristics of the fibers. It helps identify the origin and composition of the fibers, which can be used to link the evidence to a specific location or source.[18]

5) Case Studies

5.1) International Cases

5.1.a) The Murder of George Floyd

George Floyd, a black man killed by the police in Minnesota in 2020 sparked widespread protests and calls for justice. One crucial piece of forensic evidence was the autopsy report, which showed

[16] Prashant Singh, Nandini Gupta & Ravi Rathi, *Blood pattern analysis—a review and new findings*, Springer Open, Egyptian Journal of Forensic Sciences volume 11, Article number: 9 (2021), May 21, 2021
[17] Douglas W. Deedrick, *Hairs, Fibers, Crime, and Evidence Part 2: Fiber Evidence, Forensic Science Communications*, Volume 2, July 2000
[18] Brad Kelechava, "Forensic Fiber Analysis Standards", *American National Standards Institute*, July 18, 2016, available at https://blog.ansi.org/forensic-fiber-analysis-standards/ (Mar 5, 2023)

that Floyd died of "cardiopulmonary arrest" complicating law enforcement subdual, restraint, and neck compression." The report also noted several other contributing factors, including heart disease and the presence of drugs in Floyd's system. [19]

In addition to the autopsy report, forensic experts testified about the use of force by Chauvin and the other officers involved. They analyzed body camera footage, surveillance video, and other evidence to determine whether the force used was excessive and caused Floyd's death.

He was restrained by the arresting officer Mr Chauvin who placed his knee between his neck and head and held him in that position for more than 9 minutes. He repeatedly kept saying “I can’t breathe” but the arresting officer continued to use unreasonable force during the arrest.[20]

One key expert witness was Dr. Martin Tobin, a pulmonologist who testified that Floyd died from low oxygen levels due to the way he was restrained by Chauvin and other officers. Tobin used diagrams and animations to illustrate how Floyd's breathing was restricted, and he explained how this led to his death.[21]

5.1.b) The 9/11 Attacks

The 9/11 attacks were a series of four coordinated terrorist attacks carried out by the Islamic extremist group al-Qaeda against the United States on September 11, 2001. The attacks resulted in the deaths of nearly 3,000 people, including civilians, first responders, and the hijackers themselves. [22]

The Office of Chief Medical Examiner of the City of New York (OCME) played a major role in the forensic investigation of the 9/11 attacks, as it required the identification of human remains and the determination of cause of death. Forensic teams at the OCME analyzed the remains for

[19] State of Minnesota v. Derek Michael Chauvin, https://casetext.com/case/state-v-chauvin-19
[20] “George Floyd: What happened in the final moments of his life”, *BBC News*, July 16, 2020, available at https://www.bbc.com/news/world-us-canada-52861726 (Mar 5, 2023)
[21] N'dea Yancey-Bragg, Tami Abdollah, Kevin McCoy, “Expert at Derek Chauvin trial testifies that George Floyd suffocated because officers restrained him facedown and handcuffed”, *USA Today*, Apr 15, 2021, available at https://www.usatoday.com/story/news/nation/2021/04/08/dr-martin-tobin-speaks-george-floyd-breathing-derek-chauvin-trial/7141823002/ (Mar 5, 2023)
[22] Patrick Jackson, “September 11 attacks: What happened on 9/11?”, *BBC News*, Aug 3, 2021, available at https://www.bbc.com/news/world-us-canada-57698668 (Mar 5, 2023)

evidence of the cause of death, such as injuries from the plane crashes, fires, and smoke inhalation.[23]

5.2) Indian Cases

5.2.a) The Nirbhaya Case

The Nirbhaya rape case, also known as the 2012 Delhi gang rape case, was a horrific incident of sexual assault and murder that occurred on December 16, 2012, in Delhi, India. A 23-year-old female physiotherapy intern, Nirbhaya (not her real name), was brutally gang-raped and tortured by six men on a bus while returning home with her male friend. The victim and her friend were beaten with iron rods and left on the side of the road. Despite receiving medical treatment, the victim died from her injuries 13 days later.[24]

The forensic evidence collected from the victim's body and the crime scene played a key role in identifying the accused and establishing their guilt. The medical examination of the victim revealed severe injuries to her genitalia and internal organs, which corroborated the gang rape allegations. The DNA analysis of the semen samples found on the victim's body and clothing helped to identify the accused.[25]

5.2.b) The Shraddha Walkar Murder Case

Shraddha Walkar was murdered by her live-in partner Aftab Poonawalla on May 18, 2022. It is alleged that he cut her body parts into 35 pieces, stored them in a domestic refrigerator and over a period of time, he dumped the body parts in isolated areas.

The forensic team says that they might obtain some dry blood stains and skin particles of the accused and the victim from their flat and the locations where the body parts were disposed of.

[23] "Forensic Identification of 9/11 Victims Ends", *ABC News*, Feb 23, 2005, available at https://abcnews.go.com/WNT/story?id=525937&page=1 (Mar 6, 2023)
[24] Mukesh v. State For NCT Of Delhi, Cr. No. 607-608 of 2017
[25] "Nirbhaya gangrape and murder case: Scientific and forensic evidence sealed the fate of death-row convicts: SC", *DNA*, May 5, 2017, available at https://www.dnaindia.com/india/report-nirbhaya-gangrape-and-murder-case-scientific-and-forensic-evidence-sealed-the-fate-of-death-row-convicts-sc-2428852 (Mar 6, 2023)

Since there is no eyewitness to the incident, the prosecution will have to heavily rely on electronic data such as CCTV footage, GPS location and the DNA analysis of the Victim's body.[26]

6) Challenges faced in Forensic Science

India faces numerous challenges in the field of forensic science, which can hinder its ability to carry out effective investigations and ensure justice for victims. Forensic science is a complex field that involves the application of scientific principles and techniques to the investigation of criminal cases. While forensic science has made significant advances in recent years, there are still several challenges that the field faces. The NCRB data shows that the lack of evidence is a primary factor which has resulted in up to 35.5% of abysmal convictions.[27]

6.1) Limited Resources

One of the significant challenges faced by forensic science in India is limited resources and the lack of access to the latest technology. The field of forensic science is highly dependent on technology and scientific equipment to gather, analyze and interpret evidence accurately. Inadequacy of forensic labs prolongs trial and results in delay of justice[28], denying the right to speedy trial guaranteed u/a 21 of our constitution.[29]

6.2) Human Error

Human error is a significant challenge faced by the forensic science community in India. It can arise due to several reasons, such as inadequate training, high workload, fatigue, and stress. These factors can negatively impact the accuracy and reliability of forensic analysis and lead to erroneous conclusions. Over 318 convicts serving imprisonment based on faulty forensic evidence were released after DNA tests.[30]

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[26] Narayana Namboodiri, "Why Forensics could be key to Nailing Shraddha Murder case Killer", *Times Of India*, Nov 16, 2022, available at https://timesofindia.indiatimes.com/city/mumbai/shraddha-murder-case-why-forensics-could-be-key-to-nailing-killer/articleshow/95543236.cms (Mar 8, 2023)
[27] Sweekruthi K & Varsha Gowda, "The Missing Piece: Forensics in Criminal Investigation", *Deccan Herald*, Sept 17, 2022, available at https://www.deccanherald.com/specials/insight/the-missing-piece-forensics-in-criminal-investigation-1146042.html (Mar 8, 2023)
[28] Priyanka Agrawal, "Inadequate Forensic Labs Delay Justice", *The Pioneer*, Aug 27, 2022, available at https://www.dailypioneer.com/2022/columnists/inadequate-forensic-labs-delay-justice.html (Mar 9, 2023)
[29] Hussainara Khatoon v. Home Secretary, State Of Bihar, 1979 AIR 1369, 1979 SCR (3) 532
[30] V.R. Dinkar, Forensic scientific evidence: problems and pitfalls in India, International Journal of Forensic Science & Pathology, SciDoc Publishers, VIT Chennai, Feb 2015, ISSN 2332-287X

6.3) Negligence

Usually much priority is not given to some cases when a crime takes place in and among people belonging to the backward class or the unprivileged population. Certain officers of the law act in a negligent manner and fail to exercise due diligence while carrying out an initial or deeper investigation at a crime scene. Attention to detail is of vital importance in any case and negligence in handling any kind of matter in and around a crime scene can cost reliable evidence.

The Noida double murder case of 2008, also famously known as the Talvar case, involved the murder of Aarushi Talwar, a 13 year old girl and Hemraj Banjade, a domestic servant where the investigating officers did not exercise due diligence in carrying out the investigation resulting in the evidences being tampered.[31]

6.4) Lack of Standardization

Forensic science requires a high level of standardization and adherence to protocols to ensure accuracy and reliability of results. However, in India, there is a lack of standardized protocols and procedures, leading to inconsistencies in the quality of forensic evidence. This poses a challenge to the judicial system, which relies heavily on forensic evidence and opinion of experts u/s 45[32] & 45A[33] of The Indian Evidence Act, 1972.

6.5) Lack of Training

Forensic science is a highly specialized field that requires extensive training and expertise. However, in India, there is a lack of specialized training institutes and programs, and even the existing ones lack the necessary infrastructure and resources.[34] This leads to a shortage of skilled forensic scientists and technicians, and consequently, a delay in the processing of cases.

[31] Marco Margaritoff, "Inside The Still-Unsolved Murder Of 13-Year-Old Aarushi Talwar", *ATI,* July 11, 2019, available at https://allthatsinteresting.com/aarushi-talwar (Mar 9, 2023)
[32] The Indian Evidence Act, 1872 (Act 1 of 1872) s. 45
[33] The Indian Evidence Act, 1872 (Act 1 of 1872) s. 45A
[34] *Supra* note 1 at 28

7) Suggestive Measures

7.1) Funding to Establish more Forensic Labs

One of the key ways to address the challenges faced in the field of forensic science in India is to establish more forensic labs across the country. For a population of billions, an approximate of only 4500 Forensic Science Personnel are working in the Forensic Laboratories in india.[35] The establishment of more forensic labs can help to address these issues by providing more resources and personnel for forensic investigations.

7.2) Constant Equipment Upgrades

Simply establishing new labs will not be enough. The labs should also be well-equipped and well-maintained to ensure that they can provide accurate and reliable results. Therefore, it is essential to ensure that the funding provided for establishing new labs is used effectively, and the labs are updated and maintained appropriately to ensure their sustainability in the long run.

Overall, increasing funding for establishing more forensic labs in India can be an effective measure to tackle the challenges faced in the field of forensic science. It can help to improve the quality and speed of forensic analysis, which is essential for ensuring justice for victims and for bringing perpetrators to book.

7.3) Regular Training Programs

One of the major challenges faced by the forensic science system in India is the lack of trained and skilled forensic experts and investigating officers. To tackle this challenge, it is essential to establish regular training programs for these professionals.

Forensic science is an ever-evolving field, with new technologies and techniques being developed all the time. To stay up to date with the latest developments, forensic experts and investigating officers need regular training and refresher courses. This will help them to stay knowledgeable and

[35] Prachi Kathane, Anshu Singh, J.R Gaur & Kewal Krishan, *The development, status and future of forensics in India*, Volume 3, Forensic Science International: Reports, Science Direct, July 2021

skilled in their respective fields, which will ultimately lead to better and more accurate results in criminal investigations.

Regular training programs can also help to ensure that forensic experts and investigating officers are aware of the latest best practices and protocols. This can help to reduce the risk of errors and improve the quality of forensic evidence presented in court.

7.4) Stringent Legal Repercussions

There are no specific provisions in the Indian Evidence Act that deal with negligence in forensic investigation by a police officer. However, if a police officer conducts a shoddy investigation or ignores key evidence that could have been gathered, it could result in the court rejecting the evidence and lead to the acquittal of the accused.

In the Police Reforms Case[36], the Supreme Court held that a police officer can be held liable for compensation in cases of negligence in investigation under the principle of state liability. However, the prescribed punishment does not seem to be adequate enough and thus a heavy fine should be imposed. Furthermore stringent criminal proceedings should be initiated against the negligent officer u/s 166[37], 166A[38], 201[39] and 218[40], leaving no room for commutation.

7.5) Establish Emergency Response Team

Any information of a crime scene generally attracts the public who may, unintentionally or unknowingly tamper or damage the crime scene resulting in loss of crucial evidence. Therefore an Emergency Response Team (ERT) should be established, composed of highly trained forensic experts who are equipped with the necessary tools and equipment to collect and preserve evidence, in the localities where the crime rate is essentially high. Establishment of such a team can ensure that degenerative forensic evidence such as DNA is collected as soon as possible.

[36] Prakash Singh v. Union Of India, WP no. 310 of 1996
[37] The Indian Penal Code, 1860 (Act 45 of 1860) s. 166
[38] The Indian Penal Code, 1860 (Act 45 of 1860) s. 166A
[39] The Indian Penal Code, 1860 (Act 45 of 1860) s. 201
[40] The Indian Penal Code, 1860 (Act 45 of 1860) s. 218

The establishment of ERTs can help in ensuring that evidence is not lost or tampered with during the initial stages of investigation. This can help in improving the quality of evidence presented in court and increase the chances of successful prosecution.

7.6) Increased Accuracy

Accuracy of results plays a vital role in every step throughout the investigation. One misinformation can change the entire course of investigation resulting in acquittal of a guilty person and conviction of innocent individuals. To ensure accuracy the collected information should be double checked by experts and such reports should promptly be delivered to the investigating officer without any unnecessary delay.

8) Conclusion

R&D in forensic science is essential to ensure that the criminal justice system has access to the most advanced and effective techniques and technologies. The development of new methods and tools can help solve cases that were previously unsolvable and can also reduce the risk of errors and inaccuracies in analysis. Additionally, the continued development of forensic science can help to increase public confidence in the criminal justice system.

In India, the need for R&D in forensic science is more significant than ever, given the challenges and limitations faced by the field. The Indian government has recognized this need and has taken steps to establish research centers and provide funding for forensic R&D. With the proper support and investment, India can make significant progress in enhancing its capabilities in forensic science and contributing to the global advancement of the field.

Minor precautions and due diligence can go a long way in fighting crime and upholding justice. “Forensic science, a crime fighter's best mate, Bringing truth to light, sealing justice's fate.”

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Index of Abbreviations

- Article- art.
- Under Article- u/a
- Section- s.
- Unser Section- u/s
- Point- pt.
- Schedule- sch.
- Annexure- annex.
- Paragraph- para.
- Page number- p.no.
- Clause- cl
- Versus- v.
- State- St.
- Criminal Appeal- Crl.A
- HC- High Court
- SC- Supreme Court
- AIR- All India Report

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- SCR- Supreme Court Reports
- Uttar Pradesh- UP
- National Capital Territory- NCT
- VIT- Vellore Institute of Technology
- NCRB- National Crime Records Bureau
- DeoxyriboNucleic Acid- DNA
- Polymerase Chain Reaction- PCR
- Restriction Fragment Length Polymorphism- RFLP
- Automated Fingerprint Identification Systems- AFIS
- Ultraviolet- UV
- Office of Chief Medical Examiner- OCME
- Closed Circuit Television- CCTV
- Global Positioning System- GPS
- Emergency Response Team- ERT
- Research and Development- R&D