FROM CRIME SCENE TO COURTROOM: THE DOUBLE-EDGED SWORD OF FORENSIC EVIDENCE

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ABSTRACT

Forensic science has now become a great asset in the current criminal investigations, giving scientific precision and objectivity in the quest for justice. From the courtroom to the crime scene, it is vital in the determination of criminals, event reconstructions and provision of evidence to facilitate judicial rulings like DNA, fingerprints, toxicology, and digital data. Nevertheless, this growing trend towards the use of forensic evidence is both good and bad. Although it contributes to seeking truth, procedural fairness, it also introduces great legal and ethical concerns. Improper use or handling of the forensic information, more importantly, being DNA evidence, has resulted in false convictions and the grave infringement of important rights, including the right to privacy under Article 21 of the Constitution. Problems like contamination, over-dependence upon the expert opinion, absence of a regulating system, and bad forensic infrastructure still override the quality of such evidence in India.

This paper is a critical appraisal of the development and elements of forensic science, outlines the jurisprudential argument on the validity of expert evidence and pits the likelihood of miscarriage of justice based on the unregulated practice. It also examines such landmark judgments as K.S. Puttaswamy v. Union of India[1] and Selvi v. State of Karnataka.[2] The conflict between constitutional rights and forensic application is manifested in these judicial interpretations. This article suggests implementing such wide-scale changes as the development of an effective regulatory framework, ethical treatment of DNA information, and investment in forensics, as well as judicial training in the ability to effectively interpret

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[1] K.S. Puttaswamy v. Union of India, AIR 2017 SC 4161.
[2] Selvi v. State of Karnataka, AIR 2010 SC 1974.

scientific evidence. To conclude, the challenge is how to absorb forensic evidence in a rights-sensitive legal system in the quest to ensure justice is done without abridging civil liberties.

Keywords: Forensic Science, Expert Opinion, DNA, Toxicology, Privacy.

INTRODUCTION

Every criminal trial seeks to recognise truth, and truth is frequently concealed in the smallest details: a fingerprint, a hair, or a bloodstain. Forensic science acts as a silent linchpin and a witness from the moment a crime is committed, providing scientifically accurate guidance from the crime scene. In criminal trials, a high level of stringent standards is used as evidence for efficient justice administration. Forensic evidence, collected meticulously from crime scenes, victims, suspects, and witnesses, acts as strong evidence in unfolding the truth through the investigation and trial procedures.[3] Prosecutors take recourse to forensic evidence to establish their case, especially in homicide cases. DNA analysis, ballistic and autopsy reports help in determining the cause of death. Besides this, in rape incidents, DNA samples collected from the victim's body or clothing can identify the accused and corroborate the victim's allegations thereof.[4]

After independence, India prioritised various reforms to modernise its criminal procedure and justice system and to integrate forensic sciences in the investigation procedures.[5] Science plays a key role in detecting crimes as it uses the methods that are recognised worldwide, which helps in detecting the offender. The testimony of witnesses also plays a significant role in a trial, following standard rules for evidence. The witness needs to stick to the facts they saw or heard directly instead of relying on their own opinion, as "Personal Opinion" has no applicability in the court of law. It is noted that permitting a witness to give such an opinion could appear to be unfair and may be considered as 'delegation of judicial function'.[6]

Sections 39 to 45 of Bhartiya Sakshya Adhiniyam[7] deal with the exception to the above rule. Certainly, section 39[8] talks about the "Opinion of Experts". This is the reason given because the court can't give a correct ruling in cases of this kind; having such skills as an expert's

[3] Nitish Gaur, "*Forensic Evidence in Criminal Investigations in India"*, Record of Law (2024).
[4] Tsion Chudnovsky, *"The Role of Forensic Evidence in Criminal Cases"*, Top Lawyer (2024).
[5] Rhythm Sharma, "*Scientific Rigor in Legal Practice: The Influence of Forensic Science*", 4.2 JCLJ 283 (2023).
[6] Mubarak Ali Ahmed v. State of Bombay, AIR 1957 SC 857.
[7] Bhartiya Sakshya Adhiniyam, 2023, § 39-45.
[8] Bhartiya Sakshya Adhiniyam, 2023, § 39.

assistant becomes important in these cases. Indeed, expert opinion has often been described as holding strong weight in court, yet it is not enough to make a ruling by itself, as it is still an opinion and not a fact. This leads us to a growing concern in the contemporary criminal justice system due to an increasing reliance on forensic evidence, which has brought to light serious questions about the credibility and reliability of expert opinions, particularly those of forensic scientists and therefore, the potential miscarriage of justice due to a lack of accuracy in the conclusions drawn by forensic experts. While forensic evidence strengthens the criminal justice system by enhancing objectivity and accuracy, unchecked or disproportionate use can erode constitutional rights, especially privacy. Right to privacy has time and again been discussed as being an important fundamental right guaranteed under Part III; therefore, any abrogation or erosion of such a right through procedures not established by law would be held as violative of the fundamental rights. Contamination of samples is also a big challenge within forensic research. As forensic evidence is usually very small, the smallest amount of unrelated material can greatly affect the accuracy of the analysis. All these challenges and socio-legal issues, along with the practical application in various criminal scenarios, shall be further discussed in the article.

EVOLUTION AND DEVELOPMENT OF FORENSIC SCIENCES

"The *man of science in the law is not merely a bookworm. To a microscopic eye for detail, he must unite an insight which tells him what details are significant. Not every maker of exact investigation counts, but only he who directs his investigation to a crucial point".*[9]

- Justice Oliver Wendell Holmes

Forensic evidence, as physical evidence, plays a very crucial role in establishing the truth by engaging with empirical data and scientific methodologies. Globally, in Mesopotamia, Greece, Rome, etc, everything was operated based on established culture and norms and therefore lacked scientific backing.[10] Unlike ancient China, which stood out during the 19th Century with the release of a book, "The washing Away of Wrongs", which laid down various methods to examine bodies and analyse the cause of death. This was considered one of the earliest works of forensic science. Later, during the scientific revolution in the 16th and 17th centuries,

[9] Oliver Wendell Holmes, '*Law in Science and Science in Law*' (1899) 12 (7) Harvard Law Review 443.
[10] Sumiti Ahuja, *"Role of Forensic Expert Evidence in Criminal Justice Dispensation: A Critique"*, 2020 NCLJ 33.

scientific methodology and technologies gained recognition and gradually got integrated into the legal system.

During recent times, especially with the introduction of new criminal laws like Bharatiya Sakshya Adhiniyam, 2023, there has been a spurt in the use of forensic evidence for detection, like Lie detector, Toxicology, DNA analysis, Brain Mapping, Narco-Analysis, to help the justice delivery system. Various laboratories were set up during 1849, 1853, 1864 and 1870 in the metropolitan cities of India. Besides this, the first state forensic laboratory of India was set up in Calcutta in 1952. After this, there has been rapid growth in the institutional development to integrate forensic sciences into the legal system.

Presently, in India, there are about 20 well-established Forensic Sciences Laboratories.[11] Four of them are directly governed by the Central government, and there are more than 2000 scientists currently involved in forensic sciences, who deal daily with evidence materials to bring out the truth and to serve Justice. Thus, this shows that scientific and forensic evidence are being adopted in the criminal justice delivery system in India. Greater use of forensic evidence has come to be linked with procedural fairness in investigations and restores faith in the justice system. The prevalent legal framework of India recognises forensic science and technological evidence.[12] Practically, the Police are inclined towards using witness testimonies rather than expert opinions in criminal investigations. However, Section 176 (3) of Bhartiya Nagarik Suraksha Sanhita, 2023[13] has compulsorily recognised the examination of the crime scene/spot. This can be seen as an effort to integrate forensic sciences into the legal system.

COMPONENTS OF FORENSIC EVIDENCE

Forensic science provides a scientific study in the investigation of crimes and is thus an important weapon in administering justice. It carefully analyses the physical traces left at the crime scene. The forensic evidence can broadly be classified into physical, biological, digital and chemical evidence.

Physical evidence includes different material objects like fingerprints, footprints, scars, marks, weapons, and damaged materials and residues. These can be used to connect a suspect with the

[11] A.R. Lakshmanan, "*New Advances in the Field of Forensic Science and Medical Jurisprudence"*, (2005) 1 LW (JS) 85.
[12] *Dr. G.K. Goswami,* "Spreading Wings of Forensic Science", 9 SCC (2023).
[13] Section 176 (3), BNSS, 2023, https://indiankanoon.org/doc/164189086/

crime scene or to arrange the order of events. Biological evidence refers to DNA, blood, hair, semen, saliva, and other body fluids. DNA profiling is especially useful for individual identification with a high degree of accuracy.

Chemical evidence consists of materials such as drugs, poisons, explosives, and residues. Forensic chemists examine these materials to find out the composition, origin, and application. Digital evidence, which is newer but more widely recognised, involves information from electronic devices such as computers, cell phones, CCTV images, and e-mails, that can uncover communications, location, and motive. Each type of evidence undergoes strict scientific techniques, like chromatography, spectroscopy, or biometric testing, to ensure reliability and accuracy.

DNA: It is a biological substance, and an individual inherits it from their parents. It is a unique genetic blueprint found in blood, saliva, hair, and sperm of an individual. It distinguishes one from another and, therefore, can be used to identify victims and accused persons. DNA sequencing is done by forensic experts to determine the order of the four chemical blocks and allows forensic scientists to sequence short tandem repeat markers, resulting in an increased ability to differentiate between individuals.[14] DNA evidence is of very high evidentiary value in criminal investigations because it is scientifically precise in determining individuals. Its admission as evidence in Indian courts, however, depends on proper collection, preservation, and documentation. As far as the judicial interpretation of DNA evidence is concerned, in the case of *Pantangi Balarama* v. *State of Andhra Pradesh,*[15] it has been held that DNA as a piece of evidence in a rape case is acceptable, but it is subjected to specific concerns and the judge's discretion. Similarly, in the case of *State of Bombay* v. *Kathi Kalu Oghad,*[16] it was held that giving a body extraction does not constitute self-incrimination under Article 23.[17]

Narco Analysis/ Polygraph/ Brain Mapping is a psychotherapeutic technique that uses psychotropic drugs to bring into picture the mental elements and thus helps the therapist or investigating officer. Lie Detector Testing or Truth System Testing are the various Narco Analysis exams. It prevents a person from lying, and thus the truth can be found. Sections 51,[18]

[14] Sidharth Kumar Pathak, *"Forensic Science's Impact: DNA tests and Narco-Analysis evidentiary relevance"*, 2.2 JCLJ 1056 (2022).
[15] Pantangi Balarama Venkata Ganesh v. State of Andhra Pradesh, (2003) 1 ALD (Cri) 789.
[16] The State of Bombay v. Kathi Kalu Oghad, AIR 1961 SC 1808, SCR (3) 10.
[17] https://indiankanoon.org/doc/1071750/
[18] Section 51, BNSS, 2023, https://indiankanoon.org/doc/68670638/.

52,[19] and 53[20] of Bhartiya Nagarik Suraksha Sanhita, 2023, address the evidentiary significance of Narco Analysis and scientific tests. As explained in explanation, "examination" refers to "the use of contemporary, scientific methods like DNA profiling and any other test that the licensed medical professional determines is required in a given situation to examine blood, blood stains, semen, swabs in cases of sexual offenses, sputum and sweat, hair samples, and fingernail clippings".

Toxicological evidence: Toxicology is another component of the forensic field in which the biological samples are scientifically analysed to detect and quantify the amount of toxins or presence of drugs in the bodily tissues or fluids.[21] It helps in criminal investigations to determine the cause of death due to the consumption of any toxic substance. It has been time and again emphasised regarding the evidentiary value of expert opinion that the same is not decisive but is only an opinion, and because of which the courts have always been reluctant to accept it as the sole basis for conviction.[22]

Therefore, Forensic Evidence as a whole give answers to four main questions during criminal investigations, which are: "Who", "How", "What" and "When". To find the answer to who has committed the act, forensic experts perform DNA fingerprint analysis, mark or scar analysis. Forensics also tells us about how an incident took place, and it can be done through ballistic analysis, firearm and bullet comparisons, blood stain pattern analysis, etc. The question of "What" answers what was the cause of the death or any other incident, and it can be answered through Forensic Toxicology and Forensic Pathology. At last, it can also determine when an act has occurred, and this can be determined using Forensic Geology and Forensic Entomology.

LEGAL DILEMMAS OF INCREASING DEPENDENCE ON FORENSIC EVIDENCE

With advancements in science and technology, privacy rights and self-incrimination rights have been an issue of concern. The right to permissible use continues to remain uncertain. The discovery of DNA was one of the greatest achievements that humanity had made. Over the past ten years, development of DNA technology has occurred in several dynamic states such as

[19] Section 52, BNSS, 2023, https://indiankanoon.org/doc/140215112/
[20] Section 53, BNSS, 2023, https://www.indiacode.nic.in/handle/123456789/20099?view_type=search&col=123456789/1362
[21] JARRAD R. WAGNER, "AN INTRODUCTION TO INTERDISCIPLINARY TOXICOLOGY" (Academic Press 2020).
[22] Himanshu Setia, *"Evidentiary Value of Forensic Reports in Indian Courts",* 4(6) *Research Journal of Forensic Sciences (*2016).

Argentina, Canada, the United States, China and Great Britain and Scotland. They utilise the use of DNA profiling to identify persons when they are in trials for crimes in these countries or in times of disaster. DNA testing existed before the Criminal Code was amended.[23] Sections 51, 52, and 176 Bharatiya Nagarik Suraksha Sanhita, 2023, allow the taking of a DNA sample of an accused and the examination of the accused. The laws of Indian criminal procedure and evidence enable the collection of DNA samples but don't have answer to some weird questions such as how this test is going to be conducted, what standards the agency to conduct the tests will comply with and management of the data collected, since this data is highly confidential and can raise serious privacy concerns.

To address these concerns, the government has developed a draft bill on DNA profiling since the year 2003.[24] In its recent report, the Law Commission of India, had issued parameters to regulate DNA technology, following which several modifications have been carried out on the draft. The DNA profiling will enhance the proficiency of the administration of justice. The necessity to treat the privacy problem, along with human rights infringements, is hard to overestimate. DNA fingerprint, DNA test and DNA type are forensic identification methods founded on features of DNA. DNA profiling was an alternative to olden day fingerprinting techniques that proved to be simple to obscure and often display almost no trace.[25]

Genes contain a person's genetic information and are composed of a small molecule, similar to a genome of deoxyribonucleic acid.[26] In a laboratory test, every human being will be judged based on features like the texture of hair, eye colour, finger impression, etc. The DNA of an individual can be used to know how the person is growing and developing, and whether they are pregnant. The first DNA was identified in the 1860s by Swiss chemist Friedrich Miescher.[27]

DNA AND RIGHT TO PRIVACY

According to the Indian Constitution, there are possible traps in the case of using DNA or forensic evidence to establish a crime. Basic rights given to Indian people are disputable, this

[23] Smith, Marc & Gregor Frank Urbas, *"Regulating new forms of forensic DNA profiling under Australian legislation: familial matching and DNA phenotyping",* 44.1 Australian Journal of Forensic Sciences 63-81 (2012).
[24] Srivastava, Ankit, et al., *"Impact of DNA evidence in criminal justice system: Indian legislative perspectives",* 12.1 Egyptian Journal of Forensic Sciences 51 (2022).
[25] Preston & Corey, *"Faulty Foundations: How the False Analogy to Routine Fingerprinting Undermines the Argument for Arrestee DNA Sampling",* 19 Wm. & Mary Bill Rts. J: 475 (2010).
[26] Panda, Darshan, "DNA as a digital information storage device: hope or hype?", 3 Biotech 1-9 (2018).
[27] *Supra note* 18.

is since they accept their rights irrespective of whether they might be innocent or criminal. Article 21[28] of the Constitution of India guarantees "Right to Privacy" to every citizen, including the offenders.

As per *The Universal Declaration of Human Rights (UDHR), 1948,* the Right to Privacy is an integral part of human rights. Article 12 of UDHR entitles a person to protect their privacy, family, home, correspondence, etc.[29] *The European Convention for the Protection of Human Rights and Fundamental Freedoms* stipulates privacy as a human right.[30] Article 8 of the ECHR contains a particular mention of privacy. The existence of a significant amount of jurisprudence that explains privacy as a human right, besides these articles of the European Courts of Human Rights and the United Nations Human Rights Committee. In a different line of cases, a basic right of privacy has been adjudged by the Supreme Court in the past. The constitution bench of the apex court passed a recent judgment giving a new Expansion of the right to privacy to a new dimension in the case of *K.S. Puttaswamy v. Union of India.*[31] In this case, the Supreme Court, in a unanimous verdict, directed that Article 21 of the Constitution ensures that the right to privacy is guaranteed to every individual.[32] Part III acknowledges as well as promises the different aspects of freedom and dignity. Therefore, the status of privacy in the scale of these rights has come to the same level as the latter ones.

Samples of DNA, which are mostly applied in crime identification and victim identification, tend to breach the privacy of people. Consequently, it is assumed that the suspect must have been at the crime scene in case his or her DNA is identified at the crime scene. An initial sample is taken through a light scrape on the face of the targeted person in case he or she is available.

When they are unavailable, we employ the indirect techniques in terms of using hair, blood or saliva. Nonetheless, the advancement of infrastructure, skilled human force, and impeccable precision is necessary to consider the technique reliable for the purpose. There is doubt on whether it is legitimate to identify people as far as identification goes, with this method of DNA profiling.[33] The DNA Profiling technique is no exception to the rule, as no system can be

[28] INDIA CONST. art. 21.
[29] Şener & Mustafa Burak, *"A review of the meaning and importance of the Universal Declaration of Human Rights"*, 7.3 Uluslararası Politik Araştırmalar Dergisi 15-25 (2021).
[30] Brems & Eva, *"Conflicting human rights: an exploration in the context of the right to a fair trial in the European Convention for the protection of human rights and fundamental freedoms"*, 27.1 Human Rights Quarterly 294- 326 (2005).
[31] Justice K.S.Puttaswamy (Retd) v. Union of India, AIR 2018 SC (SUPP) 1841.
[32] SHARMA & BRIJ KISHORE, "Introduction to the Constitution of India", (PHI Learning Pvt. Ltd., 2022).
[33] Juyal & Rebant, *"Regulation & Use of DNA Profiling in India"* QMLJ 36 (2021).

deemed flawless. Blood, sputum, skin debris and other body cells are shed by humans during the day. It will be your suspicion in case there is some piece of hair, skin debris, or sputum at the place where a person died because of a car accident. The situation when you are a suspect, even if you are not an involved party in any crime, can be a fact that can lead to an awkward situation. Then, due to this, the quality of the evidence that would need to be provided to prove culpability would be tainted.

Discrimination against people is hardly based on DNA profiling because the test is relatively unprejudiced.[34] The problem is that law enforcement agencies, which are pervasively controlled by the state, are put straight into the line of duty. It is nowadays possible that there is state bias in the current world order as far as the treatment of individuals of other religions, castes, races, classes and genders is concerned. The DNA profiling thus turns into an instrument of the government when used against those people. The longer the information presented is, the greater the chances of record vulnerability. In the drafted bill, there appears to be a one-way tunnel, which entails everything that will ensure that an individual is attractive to be included in a database. It will include all the crimes incriminated in the schedule as outlined in the schedule of the DNA Profiling Bill 2017.

RIGHT TO PRIVACY OF ACCUSED VIS-A-VIS VICTIM'S RIGHT TO FAIR TRIAL

In *Dipanwita Roy v. By Ronobroto Roy,*[35] the Supreme Court observed that where there is seemingly irresolvable clash of the right of an individual not to be forcibly subjected to medical examination whilst the duty of the court to ascertain the truth, then the court should exercise its discretion balancing the interest of both parties and addressing whether to make a speedy decision in the matter it is imperative to put to test DNA. Having described DNA testing as a procedure in a case involving the paternity of a child, a court should not order a DNA test as a routine or standard procedure, each time such an application is made.

Over the past twenty years, there has been a call to have a special law taking care of DNA testing and profiling. The initial Bill was presented in the Parliament in 2006 and was revised in 2007.[36] Then, one more initiative was proposed in the year 2012, in which the Bill presented

[34] Coquet, Margaux & Nuria Terrado-Ortuño, *"Forensic DNA phenotyping: Privacy breach, bias reification and the pitfalls of abstract assessments of rights"*, 25.3 International Journal of Police Science & Management: 262-279 (2023).
[35] Dipanwita Roy v. Ronobroto Roy AIR 2015 SC 365.
[36] Human DNA Profiling Bill, 2007.

DNA evidence to be used as a panacea to the criminal justice system, but it failed to comment on the problem of consent.[37] A similar initiative was also proposed in the US, where there was a call to create a special legislation that will regulate the application of facial recognition and other biometric tools the balancing the dichotomy of the interests of the people and businesses.

The Malimath Committee and the Law Commission have always put their faith in DNA profiling and regarded it as an impartial scientific procedure. DNA profiling has constantly been trusted to be a precise and well-established procedure by the Malimath Committee. A specific legislation has been proposed by the Malimath Committee, the Law Commission, the Verma Committee and the Committee on Draft National Policy on Criminal Justice at various points in time.[38] The DNA Technology (Use and Application) Regulation Bill, 2019 was brought into the Lok Sabha in the year 2019. The Bill is to introduce DNA data banks to identify both victims and offenders, and suspected offenders with the help of genetic data. These banks are going to receive crime-scene DNA not just freely, provided by people who were at a crime scene, but also compulsorily, provided by people who are suspected of having committed major offences. Nevertheless, the provisions of the Bill have many problems. It has been presupposed that DNA profiling is foolproof and would assist the convicted of the accused beyond a reasonable doubt. It has also been established that as much as DNA itself.

It is unique; a DNA profile is not unique per se.[39] DNA evidence is useful in arriving at the truth, but it cannot be described as a truth machine and panacea as it used to be perceived previously. The chances of abusing the thus collected data are always there, particularly when there is no legal framework on privacy.

In the case of *K.S. Puttaswamy v. Union of India*,[40] the Supreme Court observed that privacy is a fundamental right that can only be reasonably violated after meeting the three-fold test. The first is the requirement of legality which assumes that there must exist a law which will be used to justify an infringement of privacy, the second is the requirement of a need to ensure that the law is reasonable and not arbitrary and the third is the requirement of proportionality which assumes that the means taken should be proportional to the object that is sought to be

[37] Human DNA Bill, 2012.
[38] Kirubakar Radhakrishnan, *"DNA Fingerprinting Current Perspectives and Challenges in India – An Analysis",* 2(2) International Journal of Law Management & Humanities (2019).
[39] Sunil K.Verma, Gajendra K.Goswami, *"DNA evidence: Current perspective and future challenges in India"* 241 Forensic Science International 183-189 (2014).
[40] Justice K.S.Puttaswamy (Retd) v. Union of India, AIR 2018 SC (SUPP) 1841.

achieved. Facing the Personal Data Protection Bill being withdrawn in the Lok Sabha, the case of Puttaswamy has only the ruling as the law that governs the privacy of a person. In the absence of the DNA Bill becoming a subsidiary law, even the initial criterion of legality would not be fulfilled by the process of compilation of data for DNA profiling. Even though it has been reiterated that in no way do DNA tests infringe the right against self-incrimination, following the verdict on Puttaswamy, the DNA Profiling would counter the right to privacy and hence, the right to life under Article 21 of the Constitution.

FORENSIC EVIDENCE, RELIABILITY CHALLENGES AND POTENTIAL MISCARRIAGE OF JUSTICE

Over the recent years, critics have questioned the reliability of forensic evidence and have therefore stressed reduced confidence in the expert opinion. As far as the statistics for the reliability of DNA are concerned, it has seen a decrease from a 94% rate in 2008 to 83% in 2019.[41] The reduced reliability has further impacted how the forensic evidence is weighed in court. Errors in the forensic methodologies lead to various wrongful convictions and, thus, a gross miscarriage of justice. Scientific evidence is no doubt very helpful in the criminal investigation procedures in identifying and convicting the accused person, but throughout the globe, there are various cases of expert evidence leading to wrongful conviction, like the case of *Keith Harvard*, a US Navy sailor in 1983. The courts do not expect completely accurate and correct information from the expert, but at least the information provided should not be unreasonable and illogical. As far as the tests to determine the reliability and admissibility standards of forensic evidence are concerned, there are two tests. Firstly, in the case of *Frye v. United States*[42], the Columbia Court rejected the validity of the Polygraph Lie Detector, and on the other hand, in *Daubert v. Merrell Dow Pharmaceuticals.*[43] The Supreme Court considered various factors, like a potential error in theory or technique can lead to less accurate results. This shows the potential risks of depending completely on forensic evidence to decide upon the culpability of the accused.

DNA samples are considered as cornerstone of modern criminal investigation procedures and allow the jurist to connect suspects or accused to the criminal acts. However, DNA or any forensic evidence is reliable and admissible for the court if the integrity of the sample is

[41] Smantha S., *"New Study Explores Public Beliefs about the Reliability of Forensic Science"*, Centre for Statistics and Application in Forensic Evidence" (2022).
[42] Frye v. United States, 558 U.S. 916 (2009).
[43] Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579 (1993).

maintained throughout the forensic process. Contamination of forensic samples can occur due to various reasons, like cross-sample transfer or external factors, including environmental sources.[44] Sneezing, coughing, touching evidence without gloves, and a host of other accidents are the main causes of contamination. By acquiring DNA samples from victims or nearby witnesses, for instance, some DNA-contaminated sources can be removed, and their DNA profiles can be recognised among the forensic samples gathered. It is generally recommended that police officers and crime scene investigators replace their gloves frequently and refrain from talking, sneezing, or coughing on any possible evidence. This poses a huge threat to the accuracy of forensic reports, therefore leading to wrongful convictions and miscarriage of justice. This is a contemporary issue as increased reliance on forensic evidence can result in a gross miscarriage of justice, and the laboratories should ensure best practices to prevent such DNA contamination. In the case of *Anil v. State of Maharashtra,*[45] the court stressed the need for the elimination of any possible contamination in the forensic samples. The court said that the accuracy of a particular result can vary depending on the quality control measures and laboratory procedures followed during testing. If proper protocols are not maintained, errors or contamination can occur, affecting the reliability of the result.[46] A great caution needs to be taken while handling samples. The court does take the expert opinion with trust and faith, but legal scrutiny of the evidence is necessary. The Court may be reluctant to admit some type of scientific evidence (like DNA typing) as they may feel that it does not follow the *Frye* test.

ERROR IN EXPERT OPINION

This must be noted as well that error is unavoidable. The emphasis on "Error" in forensic evidence is made due to high evidentiary standards in criminal matters. Even validated techniques cannot guarantee 100% accuracy.[47] Therefore, it is needed to reduce the potential miscarriage of justice, forensic science stakeholders and criminal justice partners acknowledge the possibility of error, comprehend its origins and occurrence, and put protections and remedies in place. Various factors affect forensic evidence, like unreliable or invalid forensic discipline, lack of funds, and insufficient validation of a technique or a method. These factors,

44 Salem K Alketbi, *"Preventing DNA Contamination in Forensic Laboratories: An Illustrated Review of Best Practices",* 24 SSRN (2024).
[45] Anil v. State of Maharashtra, (2014) 4 SCC 69
[46] Irfan v. State of M.P., 2025 SCC OnLine SC 359
[47] A.M. Christensen, C.M. Crowder, S.D. Ousley, M.M. Houck, "*Error and its meaning in forensic science"*, J. Forensic Sci. 59 123–126 (2014).

at times, lead to wrongful conviction. It has been analysed that forensic lab errors can result in a wrongful conviction and have shown a reduced reliability of forensic evidence.

There are various types of errors in forensic evidence results, which have been discussed in a report published by the Journal of Forensic Science in 2023.[48] There can be an error in the forensic science reports or individualisation or classification, in testimony at trial due to mischaracterised statistical weight or probability, excluded evidence or faulty testimony, error in evidence handling or reporting in general. Any error made by forensic scientists is associated with incompetent and fraudulent examiners, less regulated forensic discipline and infrastructure, and organisational deficiencies in training and management.

Mishandling of forensic evidence has serious consequences for the justice system. Various global cases like *Amanda Knox* and *O.J. Simpson* highlight the repercussions of mishandled evidence. In the case of Amanda Knox, there was cross-contamination of DNA samples, which compromised the integrity of the samples, and this mishandling highlighted the potential consequences of improper collection that can lead to wrongful convictions and have lasting impacts on the lives of those accused. The O.J. Simpson case also brought to light the serious consequences of faulty forensic evidence. "The mishandling of forensic evidence not only compromises the integrity of the investigation but also has far-reaching consequences on the outcome of the trial," said forensic expert Dr. Emily Johnson.[49]

Admissibility of scientific evidence has led to a serious debate in India, especially after the case of *Selvi v. State Karnataka,*[50] wherein the Apex Court has held that Narco-Analysis, Brain Mapping and Polygraph test must not be conducted without the consent of accused persons. It has raised various questions related to the basic rights of the accused. However, for evidence to be considered admissible, it must meet a few standards and must form a complete, unbroken chain pointing towards the guilt of the accused. However, it is important to demonstrate that a particular scientific or forensic evidence is reliable and authentic, and therefore it has been protected to secure its integrity. Recently, in the case of *Gajraj v. State (NCT) of Delhi,*[51] it has been held that an accused can be convicted based on conclusive, scientific and forensic

[48] John Morgan, "Wrongful *Convictions and Claims of False or Misleading Forensic Evidence,*" *Journal of Forensic Science*s, 68 908-961 (2023).
[49] Cases where Forensic Evidence was Mishandled: Exploring the Repercussions, (July 8, 2024), https://trackerproducts.com/cases-where-forensic-evidence-was-mishandled-exploring-the-repercussions/
[50] Selvi v. State of Karnataka, (2010) 7 SCC 263.
[51] Gajraj v. State (NCT) of Delhi, (2012) 1 RAJ 28.

evidence. However, there are various prerequisites regarding the nature of such evidence. It is a very well-established fact that DNA evidence is completely dependent on the suitable collection and preservation of a particular sample.[52] Any minor or simple error or negligence can contaminate the sample, and reliance on such evidence is strictly against the fair trial of the accused as well as it can lead to various wrongful convictions.

OVERRELIANCE ON FORENSIC EVIDENCE VIS-À-VIS RIGHT TO FAIR TRIAL

The interplay of forensic evidence and the right to a Fair Trial asks for a delicate balance to preserve the modern criminal justice system's integrity. Forensic science holds a significant position in present criminal investigations to uncover the truth and enhance the accuracy of investigations and trials, but the recent issue of its overreliance, particularly without ensuring proper standards and safeguards, can infringe upon the rights of the accused. Right to fair trial is a cornerstone of criminal jurisprudence guaranteed under Article 21 of the Constitution of India, which includes due process and presumption of innocence until proven guilty.[53] Digital evidence and digital forensics have recently gained prominence due to the growing use of digital devices by individuals, significantly impacting criminal investigations. The right to a fair trial is a universally recognised human right as well and is prescribed in Article 6 of the ECHR.[54] Forensic evidence, when handled with utmost precision, strengthens this framework to validate claims, but misuse, serious contamination, human error, and fraudulent expert reports only take away the sanctity of evidence and thus lead to wrongful conviction and irrevocable miscarriage of justice. In cases like Selvi v. State of Karnataka[55] and Anil v. State of Maharashtra, the Indian judiciary has tried to recognise the need for right rights-conscious approach to deal with scientific evidence in criminal trial procedure.

EMPOWERING FORENSIC EVIDENCE IN INDIA: WAY TOWARDS JUSTICE

In recent times, there has been more and more use of forensic evidence in crime cases and the trials in India. DNA profiling, digital forensics, analysis by fingerprint, and other such scientific instruments are taking a central role in deciding guilt or innocence. Nevertheless, the state of forensics in India is dotted with many constraints like unavailability of a separate legal

[52] Arun Kumar Singh, Ameesha Singh, *"Importance of Forensic Science in Law with Reference to Crime Scene Investigation"*, 26 ALJ 307 (2018-19).
[53] Zahira Habibullah Sheikh and Ors. V The State of Gujrat (2004) 4 SCC 158.
[54] European Convention of Human Rights, art. 6.
[55] Selvi v. State of Karnataka, AIR 2010 SC 1974.

apparatus, poor infrastructure, shortage of qualified staff, privacy issues, and abuse by law enforcers. In different cases, there has been a delay or false conviction of wrong forensic handling or weak safeguards. This jeopardises the position of the trust in the criminal justice system and puts the primary rights of citizens under threat, such as the right to a fair trial and the right to privacy. In order to overcome these systemic weaknesses and utilise the real potential of forensic science, it is important that India develops its regulatory, institutional and ethical policy towards forensic evidence. A better system will make delivery of such justice faster, minimise wrongful convictions, and safeguard the rights of individuals in the process.

Need for Resilient Legal and Regulatory Framework: Absence of an all-embracing, conclusive legal infrastructure that regulates gathering, keeping, examination, and engagement of forensic evidence, particularly DNA, is one of the critical issues in India's forensic evidence system. There is none; no separate law that defines the permissible limits or protection in using a biological sample. Although according to BNSS 2023, there are several provisions regarding the collection of biological samples, there is no standalone law that specifies the limits for collecting biological samples and the protection provided by the law to the sample that has been collected. The DNA Technology (Use and Application) Regulation Bill, which was introduced in 2019, seeks to control DNA profiling but has not been implemented. In the absence of such legal support, the process of collection of DNA or other biological samples may turn illegal as it will contradict the constitutional right to privacy as stated in Article 21.

The regulatory law also must be clear to state how, what kind of crimes, and how the process of consent or power of court must be obtained and how DNA evidence must not be misused. Its legislation is inspired by the case of *K.S. Puttaswamy v. Union of India*;[56] any law intervention into the autonomy or privacy of anybody must pass the caveats of lawfulness, utility, and proportionality. The creation of a statutory regulatory body to regulate the work of forensic labs and keep independent DNA databanks with controlled access should also be provided by this law.

Security of Privacy and Ethical Utilisation of DNA Evidence: DNA is a strong, but delicate instrument; it not only facilitates the recognition of a person, but it can also disclose medical, genetic, and family history. Unethical monitoring, caste or religious profiling or aberrant business use are possible consequences of the misuse of such data. As the Indian law does not

[56] K.S. Puttaswamy v. Union of India, AIR 2017 SC 4161.

yet regulate the use of Personal Data Protection, ethical treatment of DNA evidence is even more critical. Questions of privacy and possible abuse are particularly grave in a state with strong social prejudices and which has under-regulated policing.

As a procedure that should be used ethically, the legislation should also impose an obligation to withdraw only the necessary information from a sample and only in terms of identification markers, but not health issues, genetic disorders or ancestry. Exceptions to having informed consent should only apply when there are serious crimes, and this should be undertaken under court supervision. Moreover, the DNA samples and profiles amassed should be kept in ciphered databases with rigid retention and removal compliance. The data of the acquitted persons has to be deleted in real-time, and there should be serious legal implications for such unauthorised access. Such precautions will not only guard people but also increase people's trust towards the system.

Broadening Infrastructure and Human Resources Capabilities: India, as a country, lacks a developed Forensic infrastructure. There is a limited number of functioning forensic science labs in the country, which already experience backlogs on the cases, as well as use outdated equipment and lack adequate numbers of trained workers. Forensic evidence processing may not be done on time by the labs and affect the investigations negatively through delays or poor outcomes that do not comply with international standards. Lack of proper infrastructure may result in the loss of vital evidence, contamination of samples or inaccurate reports, none of which can bring a case to its knees.

To increase the forensic capacity, there is a need to have a national-level initiative. The government must invest in setting up modern forensic labs in each of the states and the districts with high-end tools and technology. At the same time, a well-trained forensic labour force should be created as well-training packages of lab technicians, forensic scientists, and even examining officials should be included in the priorities. The police department ought to be trained on how to gather evidence, chain-of-custody procedures and presentation of the forensic reports in a court of law. There should be an effort to get universities to have specialised forensic science courses and develop a long-term reservoir of talent.

Efficient Judicial Interpretation for Forensic Evidence: Although DNA and forensic evidence are also finding great use in courts, judges should be provided with the knowledge of how to interpret and use evidence in the right manner. DNA is viewed as infallible or

conclusive in most cases, and the media or the so-called CSI effect contributes greatly to it. Scientific evidence, like any other evidence, can be contaminated, erred or misinterpreted, though. Some of the Indian cases, such as Gautam Kundu v. State of West Bengal[57] and Dipanwita Roy v. Ronobroto Roy,[58] have recognised the need to have in place only those forensic tests ordered because they must be supported by the facts of the case.

Scientific literacy should be a regular feature of training that judges and lawyers should receive to know the likelihood, the margin of error of statistics, and how to make sense of forensic accounts. A forensic advisory cell, which is set up under the judiciary, may provide professional support in tricky issues. Moreover, it should be fair that both the defence and prosecution are allowed equal access to forensic experts so that the trials are fair. Courts are also obliged not to forget that forensic evidence is just one side of the puzzle, and other facts and testimonies should be aligned with it before a verdict can be made.

CONCLUSION

The application of Forensic evidence in the administration of justice has indeed transformed the criminal investigation and the processes in court play as it has brought in the element of scientific accuracy in the pursuit of justice. From finding the crime culprit to recreating the crime scene, forensic science is one of the stalwarts of current legal procedures. Nevertheless, with this development, issues related to the right to privacy, credibility of expert witnesses and the possibility of abuse of scientific evidence or overdependence on science are always associated. It is high time to create a strong legal framework governing the gathering, storing and use of DNA and other forensic information, as there are grave concerns in this respect on constitutional and ethical grounds. Indian criminal justice system is slowly adopting the forensics tools like DNA profiling, Narco-analysis and computer forensics; however, unless proper checks are put in place against malpractice, the tools are likely to be abused. Hardships of sample contamination, non-standardisation, infrastructure weakness, and inadequate training of forensic analysts are the primary areas that cause erroneous results to be obtained, even at the cost of failing investigations and creating miscarriages of justice. Such rising dependence on forensic methods should, accordingly, be tempered by suitable legal, procedural

[57] Gautam Kundu v. State of West Bengal 1993 (3) SCC 418.
[58] Dipanwita Roy v. Ronobroto Roy, AIR 2015 SC 418.

and ethical safeguards so as not to contravene the constitutionally guaranteed rights of the accused persons and, more notably, the right to receive a fair trial under Article 21.

Making sure that forensic evidence plays a constructive role in the justice system, India needs to introduce a robust system of regulations, list institutional infrastructure and make sure that stakeholders in the judicial and investigation fields are trained to deal with and understand scientific evidence with discretion. And guarding the informational privacy of an individual will be very important by having informed consent, stringent statutes of data protection and checks and balances.

Therefore, forensic science is an efficient instrument, as well as any instrument; it makes an impression that is superimposed upon it. Forensic evidence may dominate the principles of justice and truth when incorporated in a responsible and ethically acceptable manner. Nevertheless, unregulated reliance may spell a reversal of the rights it tries to uphold.