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INFUSING PCAST METHODOLOGY IN SETTING PROBATIVE STANDARDS FOR EXAMINATION OF FORENSIC EVIDENCE

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ABSTRACT: The PCAST methodology anchors the scientific validity of forensic evidence to ensure that what evidence enters the courtroom is not just persuasive but accurate enough to be relevant and admissible. Crime happens within the contours of closed doors; circumstantial evidence is tested on the cornerstone of cross examination, is only reliable link to establish culpability in criminal offences. The other important piece of evidence which is most relevant is forensic evidence, but whether its scientifically reliable is not is the next pertinent question to be asked to establish the culpability of offenders. In this scenario the Presidents' Council Advice on Scientific Evidence and Technology (PCAST methodology) is a useful tool, which refers to the 2016 report by the President's Council of Advisors on Science and Technology in the Unites States of America to establish the scientific rigour and admissibility of forensic evidence in criminal cases. In India, the guiding principle of criminal justice is that even if a thousand guilty individuals are acquitted, not a single innocent person should be wrongfully convicted. Hence, it's essential that scientifically reliable forensic evidence should be presented in the court of law. The accuracy benchmark introduced by PCAST represents a landmark shift into forensic methodologies. The current state of literature shows an abundance of forensic techniques from fingerprint and bite-mark analysis to DNA profiling but lacks a scientifically validated framework for each kind of forensic evidence which this article lays the need to stress upon. The research relies on a doctrinal analysis of the PCAST report, drawing insights from comparative legal frameworks across jurisdictions and highlights data from secondary empirical studies and concludes by identifying critical gaps for future research to maintain accuracy around all forms of forensic evidence and the urgent need to evaluate and upgrade India's forensic infrastructure, which remains under-equipped and often lacks uniform procedural standards. Thus, this study is both a call to action and a proposed blueprint for improving scientific reliability of forensic evidence, ensuring that justice is guided by science, not speculation.

Keywords: forensic evidence, scientific reliability, probative value, PCAST methodology.

I. INTRODUCTION

Crime happens in closed doors by expert offenders who design the execution of the offence in such a manner that neither direct evidence nor eyewitness testimony is available to help the investigative authorities to bring establish the mystery of the offenders. Here comes the importance of circumstantial evidence that caters to all the missing links of the chain of causation that helps to establish the culpability as held in the case of Nisha v. State of Orrisa[1] but forensic evidence too plays an important role to establish the culpability but while the accuracy of circumstantial evidence is tested on the cornerstone of cross

examination and completion of the link of chain of causation. To establish the scientific validity and accuracy of forensic evidence is a crucial task. The Presidents' Council Advice on scientific evidence and technology (PCAST methodology)[2] is a useful tool in this regard which refers to the 2016 report by the President's Council of Advisors on Science and Technology in the Unites States, its relevance is highly debated to establish the scientific rigour and admissibility of forensic evidence in criminal cases. The forensic evidence collected on ground post the commission of a criminal offence has to pass the test of scientific validity to establish culpability, hence PCAST methodology has a major role to play in this regard in enhancing the quality of investigation and for a fair and effective prosecution as importance of accuracy in criminal adjudication.

The sensational Arushi Talwar murder case[3] in India wherein so much of lacuna was found in the investigation of the forensic evidence found as after the commission the body of the Arushi Talwar was exposed to the human touch of several people who came to visit after her death to the fault of investigative officer who found the dead body of Hemraj found locked in terrace several days after highlights the concerns India faces in terms of the lackadaisical approach of the investigative authorities. Further the judgement given in the heinous Nirbhaya rape case[4] is also not free from fault as one of the major factors to establish the culpability was based upon the bite marks of the accused on the private parts of the victim. Here it's important to highlight the fact that human race does not have a unique teeth lining, hence to establish the culpability upon the bite marks of the accused is also not free from defect. The importance of PCAST report brings forth various categories of forensic evidence with their peculiar scientific validity and accuracy.

Nature of crimes in today's age is constantly diversifying, hence cybercrimes also poses new hurdles and challenges and demands a constant adaptation and innovation in forensic investigation domain particularly highlighted by the Supreme Court of India in the case of Mohd. Arbaz and Others v. State of NCT of Delhi[5] wherein the deficiencies noted in Forensic Science laboratories across the countries was noticed.

II. RELATED WORK

The Literature Review section constitutes the scholarly cornerstone of this research endeavor, meticulously surveying and synthesizing a diverse array of judicial pronouncements, forensic studies, and empirical investigations relevant to the application of scientific methods in legal contexts. Within this section, the narrative unfolds as a tapestry woven from the threads of landmark judgments, including Nisha v. State of Orissa, (1997) 8 S.C.C. 40, and Mukesh v. State (NCT of Delhi), (2017) 6 S.C.C. 1, which exemplify the judiciary's reliance on expert testimony and the rigorous application of scientific principles. Complementing these legal perspectives, empirical and theoretical studies, ranging from foundational analyses of physical evidence (Taylor, 1944; Kirk, 1953) to contemporary explorations of DNA and feature comparison methods (Saks & Koehler, 2005; Koehler, 2017; Scurich, Faigman & Albright, 2023; Butler, 2014), highlight the evolution and growing sophistication of forensic science. High-profile criminal cases, such as the Aarushi Murder (NDTV, 2012) and the Sooraj–Uthra Snake Bite Murder Case (Patel, 2022; Sooraj v. State of Kerala, 2025 KER 28219), illustrate the critical role of forensic evidence in reconstructing events and establishing culpability, while studies on laboratory integrity and contamination risks (Natarajan & Kulkarni, 2020; Turner et al., 2016; Budowle & Swanson, 2015) underscore the importance of procedural rigor. Legislative frameworks, including Section 116 of the Bharatiya Sakshya Adhiniyam, 2023, provide statutory support for the admissibility and treatment of evidence, ensuring alignment with scientific standards. Further, interdisciplinary perspectives on the governance of science in legal processes (Evans & Matthews, 2024), the epistemology of forensic methods (Cole, 2019; Lee & Gaensslen, 2018), and the integration of mental healthcare considerations (Sethi, 2021) reveal the complex interplay of science, law, and ethics. By critically examining these diverse scholarly contributions, this review not only elucidates the theoretical and historical foundations of forensic science in the Indian judicial context but also identifies gaps, discrepancies, and emerging challenges, thereby providing a comprehensive foundation for the present investigation and guiding its analytical trajectory.

III. MATERIAL AND METHOD

The Materials and Methods section encapsulates the blueprint of the research endeavor, meticulously delineating the tools, procedures, and approaches employed to explore the research questions within the doctrinal legal framework. This study primarily adopts a qualitative, doctrinal research design, systematically analyzing statutes, judicial pronouncements, scholarly articles, and reports relevant to forensic evidence, criminal investigations, and the intersection of law and science. The materials utilized include primary legal sources such as judgments and statutory provisions, as well as specialized legal commentaries and textbooks. Secondary sources comprise peer-reviewed journal articles, empirical studies, news reports, and comparative analyses on forensic science and expert evidence. The procedure involved a systematic collection and critical examination of these materials, focusing on the principles, methodologies, and judicial reasoning applied in the context of forensic and scientific evidence. Data analysis was conducted through a rigorous synthesis of the doctrinal materials, identifying patterns, inconsistencies, and interpretative nuances in judicial approaches, while also integrating interdisciplinary perspectives from forensic science and epistemology. Ethical considerations were observed in the accurate attribution of sources, maintaining objectivity, and avoiding misrepresentation of legal findings. Limitations of the study pertain to the reliance on published judgments and literature, which may not capture unpublished case-specific forensic data. Overall, this methodology ensures a structured, transparent, and comprehensive examination of the doctrinal and practical dimensions of forensic evidence in Indian criminal jurisprudence.

IV. RESEARCH DESIGN

This subsection delves into the qualitative research design employed in this study, which focuses on the systematic examination of legal texts, judicial pronouncements, statutory provisions, and scholarly writings. The approach is oriented toward understanding the principles, reasoning, and interpretations embedded within legal and forensic contexts, emphasizing the meanings and implications of judicial decisions and legislative frameworks. Data collection involved the careful selection and review of relevant legal documents, case law, and academic literature, while analysis was conducted through content analysis and doctrinal synthesis to identify patterns, interpretative nuances, and evolving trends in the application of forensic evidence. This qualitative approach enables a deep exploration of the contextual and theoretical dimensions of law, facilitating insights into the interplay between statutory mandates, judicial reasoning, and scientific principles within the Indian criminal justice system.

V. CLASSIFICATION OF FORENSIC EVIDENCE

Forensic is a Latin term meaning the “Forum” which was a meeting place in Rome in ancient times where civil and legal matters were discussed by persons holding public responsibility.6 Today forensic science is sometimes substituted in academics as medical jurisprudence of the 19th century. Forensic Evidence differs much as compared to oral, documentary or real evidence as they have to pass through the filters of relevancy, admissibility and has probative value which the judge believes to be true after being proved. Forensic evidence on the other hand is based upon scientific principles to ensure its accuracy and correctness tested upon scientific principles wherein the judicial approach evaluates forensic evidence to assist the court to arrive at a logical situation based upon scientific principles.7 The accuracy of collection of forensic evidence and reliability of its analysis are critical factors in criminal cases when assessed through the lens of PCAST methodology.

The scope of forensic evidence is very wide: from DNA evidence to adjudge paternity in civil cases for drawing a conclusive presumption8 in the favour of the child. Thus, determination of paternity when talked about in context of DNA test is forensic evidence. Next comes are handwriting and thumb impressions useful for execution of documents, these are scientific facts falling within the domain of forensic evidence.9 Determination of age through bone ossification tests useful in cases of juvenile offenders10 all fall within the category of forensic evidence.

In criminal cases, to ascertain the time involvement of the accused i.e. the time of his presence,11 traces of physical matters like hair, sweat, bite marks, blood stains, fingering details in sexual offences12 particularly the semen are all important forms of forensic evidence gathered from the place of occurrence.

Further brain mapping, truth serum and lie detector tests, blastics, gunshot injuries, skull identification, face detection all such forms of real evidence are seen through the peculiarities gathered by forensic evidence.13

VI. SCIENTIFIC RELIABILITY OF FORENSIC EVIDENCE

In the United States there is an automatic feed of scientific materials report sent from scientific community to the President who sends it across the states for the courts to follow. The Presidents' Council Advice on scientific evidence and technology (PCAST) report suggests a unique feature comparison method14which is in vogue as the President's report is a matter of significance for the scientific community at large as they are worried and concerned about the manner of application of these scientific tools by the judiciary in determining the cases.

PCAST argues that the reliability of various kinds of forensic evidence differs hugely, from DNA test or a thumb impression which is believed to be a perfect science15 as it is infallible as every human gene is unique, to a handwriting or a bitemark which is considered as imperfect science as it is not unique in human race. This forms a bone of contention regarding the various categories of forensic evidence as if culpability is established upon its basis, then its pertinent to be scientifically accurate and reliable.

In legal context specifically in matters related to litigation related to forensic science and medicine which is applied more in criminal cases rather in civil cases. The reason behind it is that the burden of proof in civil cases is preponderance of probability as opposed to proving the guilt of the accused beyond reasonable doubt in criminal cases16 wherein the guilt needs to be proved to the hilt. Hence for establishing culpability in such cases, the validity of evidence needed to be proved against the accused needs to be perfect based upon reliable scientific evidence which is in fact forensic evidence.

VII. BURDEN OF PROOF IN CIVIL AND CRIMINAL CASES

Forensic evidence in interplayed in of criminal justice process particularly at the investigative stage which seeks to identify the likely perpetrator of the crime for which the insights might flow from well-established scientific exploratory approach to establish the guilt of the accused to the hilt i.e. beyond reasonable doubt. Hence forensic evidence must satisfy the highest standards here. Then comes the point of satisfying the judicial mind at the dais who is the final arbiter to judge the accuracy of the forensic evidence. Thus, the need is the "best evidence" should be produced to determine culpability which the PCAST methodology claims to intersect the legal and scientific standards together. If the evidence crosses the admissibility test, judges accept it this forms part of the legal standard, but decisions require making the determination about scientific validity which is the most proper form of evidence that the scientific community can offer.

In civil matters, paternity disputes under the Indian Evidence Act, 1872 illustrate this evolution. Section 112 provides for a conclusive presumption of legitimacy when a child is born within 280 days of the dissolution of marriage. However, questions of paternity today are increasingly examined through the lens of forensic science, particularly forensic DNA analysis, which has become central to resolving such disputes. Another important dimension of forensic application lies in the execution and authentication of documents. Handwriting analysis, thumb impressions, and signature verification are scientific methods used to establish the identity of a person and the genuineness of documents. These constitute scientific facts and fall squarely within the ambit of forensic evidence.

Forensic science also plays a pivotal role in determining age through bone ossification and other medical tests, which are crucial in matters relating to guardianship, juvenile justice, and criminal liability, where the ascertainment of minority is decisive. Similarly, in cases involving transplantation of human organs, forensic and medical examinations such as cross-matching and compatibility tests are indispensable, particularly when courts authorize such procedures. Further, forensic evidence is extensively relied upon in matters concerning mental health. The legal framework governing mental illness has evolved from the Indian Lunacy Act, 1913 to the Mental Health Act, 1987, and is now governed by the Mental Healthcare Act, 2017.17 These statutes necessitate forensic and medical assessment to determine the mental condition of parties, their legal capacity, and the rights of persons with disabilities. Forensic evaluation is central to deciding whether a person is mentally ill and the extent to which such illness affects legal responsibility and entitlement.

Additionally, forensic science assists in sensitive medico-legal questions such as determining whether a woman should continue a pregnancy, assess foetal health, and identify genetic disorders or abnormalities in the unborn child. In all these contexts, forensic evidence has emerged as an indispensable tool guiding judicial decision-making. In criminal investigations, establishing the involvement of the accused often depends on determining their presence at the scene of occurrence and whether they left behind any physical traces. Such traces may include hair, sweat, fingerprints, and, particularly in cases of sexual offences, biological evidence such as semen. These forms of physical and biological evidence are crucial and are typically collected from the place of occurrence to reconstruct the sequence of events and link the accused to the crime.

The use of scientific techniques such as brain mapping, narco-analysis (truth serum), and lie detector tests has been expressly prohibited by the Supreme Court in Selvi v. State of Karnataka, as their compulsory administration violates the constitutional protection against self-incrimination and the right to personal liberty. Consequently, it is procedurally impermissible for the police to compel an accused to undergo such tests, and public prosecutors are equally barred from relying upon or seeking their use during trial. Forensic medicine plays a vital role in criminal cases involving explosives and firearms, where bomb blasts and gunshot injuries are examined through their distinctive forensic characteristics. Further, forensic science aids in identification through techniques such as skull identification and facial reconstruction, especially in cases involving complete disfigurement of the body. These methods constitute significant forensic evidence and assist courts in arriving at a scientifically informed conclusion.

VIII. PCAST REPORT

The President's Council Advice on Scientific Evidence Science and Technology (PCAST) report is a report ensuring all the scientifically established principles ensuring feature comparison method to assess each category of forensics evidence ascertaining its accuracy. In US and UK, there is an automatic feed of scientific materials, the scientific community report about the accuracy of every forensic test to the President who sends it to the Attorney General who sends it across the states, for the courts to follow such scientifically established principles helpful to assess forensic evidence and deciding the cases. This concept is particularly in vogue as the President's report is an immense matter of significance as the judges apply the scientific tools to adjudicate civil and criminal matters alike.

Hence the central theme of this paper is that how facts should be appreciated scientifically which is the aim of the PCAST report ranging from topics such as thumb impression to footprints to bitemarks to DNA analysis, a question constantly revolving around the minds of doctors and lawyers and judges alike. The courts rely upon the testimony of an expert testimony who assess scientific validity of forensic evidence which are established on scientific principles that have been reliably applied through PCAST methodology. Hence an expert should keep such scientific principles in mind to ascertain the reliability of forensic evidence.

The main bone of contention in this paper is that the eligibility of various forensic evidence is placed on various pedestal i.e. a thumb impression believed to be believed to be infallible and a perfect science to handwriting expert testimony believed to be an imperfect science. It is essential to know the scientific validity of such techniques as in a legal context specifically in matters related to litigation wherein forensic medicine and science is applied to determine accuracy of evidences, more prevalent in criminal cases rather than in civil cases as burden of proof in civil cases is the preponderance of probability as opposed to proving the guilt of the accused beyond reasonable doubt in criminal cases. Hence the validity of evidence needed to be proved against the accused in criminal cases needs to be perfect backed upon scientific evidence which inturn is called forensic evidence.

IX. PHASES OF CRIMINAL TRIAL PROCESS

Forensic justice is used in two phases of criminal justice process, first is investigation which seeks to identify the likely perpetrator of the crime for which the insights and the information may come from both well-established science and exploratory approaches. Second, the prosecution which seeks to prove the guilt of a defendant beyond reasonable doubt, here forensic science must satisfy higher standards. Hence scientific evidence is opinion based, how that person has formed that opinion, essential to satisfy the judicial mind as

the judge is going to be the final arbiter who is going the judge the correctness of the evidence. Thus, the whole crux of forensic science is such that best evidence should be served on the plate to achieve justice for decision in cases. This is where legal standards and scientific standards intersect as judges' decision about the admissibility test rests solely on legal standards. They are exclusively within the province of the court and no expert can substitute that opinion or finding. However the decisions require making the determinations about scientific validity. Hence what is proved in law is what the judge believes himself to be true.

Evidence gives the expression "belief that someone believes to be true"18, this expression however needs to be ascertained as this belief is not like simple faith but belief based upon scientific principles like forensic evidence.19 The whole new approach as given by PCAST is a forensic feature comparison method that is a process employed to find whether an evidentiary sample like real evidence obtained from a crime scene is or is not associated with a potential source sample from the suspect based upon presence of similar patterns, impression features or characteristics in the sample and the source being either DNA, hair, latent fingerprint, firearms and spent ammunition, tool and tool marks, shoe prints and tyre marks, bitemarks and handwriting.20 Feature comparison also depends upon a huge determination of purity of the sample collected, these standards were breached enough like in the sensational

Arushi Talwar Murder Case21 wherein the victim was killed through profuse bleeding and died, simultaneously Hemraj's dead body was also found upon the terrace dragged from the place of crime and hidden there found much late at the stage of investigation.

In this case the major lapse that happened was purity of the forensic evidence collected as many people came and touched various things around the place of occurrence of crime. To assure the credibility of feature comparison method in PCAST methodology depends upon the purity of the sample as it lays down the perfect foundation of investigation. In cases of sexual offences, like delay in taking of samples like a condom which is said to be a visiting card for investigation in sexual offences, there is nothing more certain than taking material from there, but where a condom is not used then scrapping the material out of the crime scene becomes very important. To ascertain accurate outcome through the use of PCAST methodology evidence should be properly obtained as it forms foundational validity of arriving at correct conclusion as the feature comparison method should always be objective that is definite, standard and quantifiable22 as opposed to subjective method which involve key human judgement as to which features need to be selected within a pattern.

The analysis into validity as applied requires an analysis into whether the forensic examiner is capable of reliably applying this technique as whether the examiner has actually reliably applied the technique. All this is going to come from an expert and how this expert evidence needs to be seen or approached is that inorder for the report to have a probative value, it must be based upon empirical studies wherein a pattern can be reflected that accurate forensic evidence yields certain results.

Take for instance the brutal Nirbhaya rape case23 wherein to establish culpability of the accused semen samples were collected from the spot, vehicle number was identified and the number of persons travelling in that vehicle at that time were recorded. The accused were then subjected to DNA analysis and compared to the semen taken on spot.24 The case was then decided by the Supreme Court taking into consideration bite marks of the accused near the pubic region and the breast of the victim guaranteeing by the apex court "that evidence has been properly investigated from Pune Forensic Lab"25 and it has brought out the truth.

The point of controversy here is that PCAST shows bite mark evidence as the weakest evidence possible as the alignment of teeth in humans is not at all unique. The tooth marks and the bites cannot ascertain as it belongs to a certain person. Thus, bike mark evidence has no scientific validity at all. Hence the courts have to cautious enough while basing their judgements as evidence to be relied upon should be scientifically tested. In a scientific world it is the best evidence that needs to be relied upon as from the stage of purity in sample collection to effective examination of evidence to placing judgement on corrected technical parameters as, evidence needs to be proved at a hilt in criminal cases i.e. beyond reasonable doubt of certainty. If it is suspicious then it becomes a matter of great concern. All these standards of proof need to be properly applied. The expert in his report should not make any claim which goes beyond scientifically applied empirical evidence.

X. CAUTIONARY PRINCIPLES OF FORENSIC EVIDENCE

Certain categories of forensic evidence are scientifically viable for example placing reliance on DNA evidence which is 99.9% reliable but the probability of 0.1% fault also should not be ignored. Fault of negligence in assessing the liability through such forensic evidences cannot be ignored. In United States v. Jakobetz26 case which involved a simple mixture of DNA of two individuals to ascertain the paternity of the claimant, as by mistake the wrong DNA sample was mixed in a Petridish, but since DNA analysis is an objective method in which lab protocols are precisely defined27, here it is not a problem as the process is repeatable, reproducible and accurate. However, caution should be exercised as errors do occur when there is a sample mix ups and contamination involving incorrect interpretation and errors in reporting.28 In gang rape cases also wherein the semen sample is mixed, identification of every accused separately becomes difficult.29 Thus in complex mixture samples of multiple unknown individuals of unknown proportion arising from mixed blood stains and increasingly multiple individual touching a surface at the scene of crime before collection of evidence like happened in the case of Arushi Murder Case30, the probability of incorrectness of 0.1% of the DNA samples needs to be carefully analysed. The fundamental difference between the former and the latter lies not in the process adopted but in the interpretation of the resulting DNA profile i.e. tests.

Sometimes it's the forensic investigators themselves who accidentaly contaminate the evidence. In UK a man named Adam Scott was wrongfully convicted of rape when his DNA was found in a genital swab. Scott's DNA was a perfect match, a one in a billion probability and it was the only evidence used to convict him, despite Scott's claim that he was more than 200 miles away from the night of the incident. Scott spent five months in custody before the truth came out when a technician in the crime lab had reused a plastic plate that contained a sample of Scott's saliva from an unrelated "spitting" incident, phone records led to corroborate Scott's claim that he was in hometown at the time of the attack. Hence purity of the sample needs to be ensured at the instance of the police or the forensic lab.

In Sooraj v. State of Kerala31, a man went and reported to the police that his wife was bitten by a snake and has died. The man stated that he found out the snake and killed it. The dead snake was also placed in evidence. The forensic evidence found was that snake was a cobra and cobra cannot claim more than 50% of its length. The wife at the time of the incident was lying on the cot and death was due to snake bite, could not be established.32 Further the fangs of the bite was in the throat and below there was another one, the court held that on the basis of forensic evidence that cobra is a shy snake and bite mark was wider than it can bite, only when a cobra is made to be deliberately bitten then only the bite mark can be extended. Hence forensic evidence when very carefully examined, it was found out that the snake was deliberately placed on the bed, made to bite two times on neck of the wife and was suffocated to death. Thus, we see that forensic examination when achieved to perfection can make the maxim alive in criminal law prosecution that even if 1000 guilt persons are acquitted one innocent person should not be convicted.33

When a doctor or an expert gives an opinion about the accuracy of the forensic evidence collected, it should be on the basis of empirically tested established principles of PCAST methodology that makes forensic examination of evidence scientifically valid and certain. When a doctor or an expert writes an opinion after examination of forensic evidence the language used should be uniform as suggested by PCAST. The examiner should provide the quantitative information as percentage of chances of error in examination like in case of DNA sample examination, error percentage is minimal, but examiners should be careful as mistakes can occur both due to similarity in features and human error in labs.

XI. ART OF CROSS EXAMINATION IN FORENSIC EVIDENCE CASES

In the cross examination the questions will be asked to the experts regarding who brought the sample, what was the statement that was given by the victim or the witnesses, what did they record, as there is also potent as the likelihood of bias in suc cases is pertinent. There can be confirmational bias, contextual bias, and proficiency testing.

In Arushi murder case34 the person who did the post mortem was a very young person who confessed that he had never conducted any post mortem before. The proficiency of the person was itself brought into challenge and the High Court was acquitted and reversed the judgement passes by the trial court.35 Hence

these issues act as a weapon in the hand of the defence counsel when it comes to testing the rigors of forensic evidence. This falls into the lap of purity the chain of custody when forensic evidence changes hands while investigation.

The felinity to establish the chain of custody of evidence was highlighted in the year 2015 when a forensic researcher asked pairs of people to shake hands for two minutes and then handle separate knives. In 85% of the cases, DNA from both the people was found on the knives and 20% of the cases showed more DNA from the secondary source than the primary source.36 Sometimes it's the forensic investigators themselves who accidentally contaminate the evidence like happened in Scott's case37.

Thus the six areas where forensic evidence needs careful consideration and cross examination can be based upon it are first the collection methods and conditions, second is established chain of custody, third is purity of forensic sample, fourth is non tampering of sample, fifth is medical condition of the attacker particularly in sexual assault cases and sixth is limitation of the current technology. These are perfect anomalies in the field of forensic investigation. Hence to establish culpability of the accused forensic evidence added to other factors of circumstantial evidence should be taken into consideration.

XII. CONCLUSION

Judges, as the intellectual anchors of the judicial process, must ensure that scientific evidence admitted before the court satisfies well-established scientific standards. Both judges and lawyers should critically assess whether the expert testimony is founded on reliable principles and methods, and whether those principles have been competently and correctly applied to the facts of the case. The foundational validity of expert evidence lies in the reliability of the methodology, while its applied validity depends on the expert's competence in using that methodology in the given factual matrix. Accurate disclosure of known or potential error rates is equally essential. Only when these safeguards are observed can post-assault physical manifestations meaningfully strengthen a conviction.

XIII. ROLE OF THE EXPERT AT TRIAL

At trial, an expert must clearly establish their credentials by demonstrating their scientific knowledge, professional experience, and prior work or reports. This enables the court to comprehend the evidence without being overwhelmed by technical jargon and ensures clarity and transparency. Where the scientific issue is novel or evolving, experts may legitimately rely on authoritative scientific literature for corroboration. They must address the probative value of their findings, explain the likelihood of errors, and distinguish between true positives, true negatives, and the risk of false positives.

Before relying on expert evidence, the court must rigorously test the expert's qualifications and subject the testimony to careful examination through the expert's report. The expert should be thoroughly conversant with the contents of the report, explain technical terms in an accessible manner, identify the scientific sources relied upon, and candidly acknowledge that their conclusions are expressed in terms of scientific probability rather than absolute certainty. When these criteria are satisfied, expert evidence can be appropriately evaluated and effectively assist the court in arriving at a just decision.

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