Forensic DNA Profiling: Legal and Ethical Considerations

ABSTRACT

Forensic DNA analysis is vital in criminal investigations, posing intricate legal and ethical dilemmas. This emphasises the need to balance DNA technology benefits with individual rights, prioritizing privacy, consent, and ethical practices. Stringent regulation of DNA data management is essential to prevent misuse and ensure privacy protection. Advances like probabilistic genotyping software improve interpretation accuracy, addressing complexities in mixture analysis. Responsible DNA use also requires navigating emerging technologies like next-generation sequencing while upholding ethical standards. Establishing transparency, accuracy, and ethical conduct throughout the analysis process is crucial for building public trust. Regulatory oversight and accountability mechanisms are necessary to address errors and maintain fairness in DNA data management. Through continuous dialogue and adherence to ethical standards, the forensic community can uphold scientific integrity and preserve public confidence in DNA analysis.

Keywords:DNA Profiling, Accuracy, reliability,

1. INTRODUCTION

The manuscript "Legal and Ethical Considerations in the Use of DNA Fingerprinting" highlights that DNA profiling is crucial in forensic investigations and presents complex legal and ethical challenges (1). Moreover, Tiwari (2024) correctly emphasised the significance of striking a balance between the advantages of DNA technology in criminal justice and individual rights, considering privacy, consent, evidentiary reliability, and ethical implementation. Regulating DNA data management is crucial to prevent misuse and protect privacy. Legal frameworks are essential for overseeing DNA collection, utilisation, and distribution, promoting trust by being transparent and fair. Global crime investigation requires international standards. Regularly revising and adapting ethical and legal standards is crucial to keep pace with advancements in DNA technology (1).

We welcome the fact that Tiwari (2024) shared their insights on the fact that the future of forensic DNA identification hinges on striking a balance between its forensic benefits and safeguarding individual liberties and privacy (1). Continuous dialogue among scientists, legal experts, ethicists, and the public is essential. This ensures scientific advancement while upholding ethical and legal principles. DNA fingerprinting underscores human ingenuity and emphasises the responsibility to use this power wisely and ethically. It serves as a reminder to prioritise protecting individual rights and pursuing justice in its application. We intend to capitalise on the insights presented in the manuscript by focusing on some key points discussed that warrant further deliberation.

2.ACCURACY AND RELIABILITY

The accuracy and reliability of forensic DNA must be assured by implementing a quality management system for forensic DNA analysis and the administration and management of the forensic DNA database on ISO 17025 and ISO 9001, respectively (2, 3). Apart from internal inspections and audits to assess compliance with the QMS and the ISO standards, the QMS and testing methods must be exposed to regular external peer review through accreditation. Accreditation

boosts trust in the laboratory's efficient management system that adheres to strict standards for verifying competence, technical procedures, and result communication. Accreditation boosts trust in the laboratory's efficient management system that adheres to strict standards for verifying competence, technical procedures, and result communication (4). It is the basis for continuous enhancement in the laboratory's management system. It is the basis for continuous enhancement in the laboratory's management system. The QMS supports continual improvement and endorses a risk identification and mitigation approach in laboratory management. It is crucial to identify the core processes in the DNA laboratory and set specific quality objectives (key performance indicators with deliverable indicators) that align with properly managing these processes. Every DNA test method should have clearly defined quality control measures such as, but not limited to the following where appropriate: positive and negative controls, internal standards, and allelic ladders. Quality control scatter charts should document particular critical parameters of each test batch to assess graphical quality performance. This allows for assessing the daily test method's performance compared to the verified test performance (3, 5).

Interpretation issues on forensic DNA results are more often associated with the DNA mixture samples. Interpreting DNA profiles manually or employing the binary method might lead to subjectivity among analysts because of possible variations in interpretation. Allelic dropout, drop-in, allele sharing, and PCR artefacts impede manual interpretation. DNA deterioration caused by environmental factors can impede interpretation. Probabilistic genotyping software (PGS) has significantly progressed over the last 15 years to assist in analysing complex combinations and enhancing DNA profile interpretation (6, 7, 8).Moreover, before forensic DNA test methods are implemented in the laboratory, the test method must be exposed to validation testing. The laboratory uses biodata analytics generated in the laboratory to make informed decisions on cut-off values. The scientific and appropriate decision-making becomes paramount at quantification and electrophoresis threshold values. The laboratory must appoint a DNA technical leader with at least a master's degree qualification in biochemistry, genetic or molecular biology, with intensive DNA laboratory experience and has undergone in house training in DNA coursework. The technical leader will be responsible for the ongoing scientific validity of the DNA technology and DNA test methods employed in the laboratory. The technical leader will be required to defend the scientific validity of the test method used in the laboratory (3). It is essential that before any forensic DNA test result ~~of~~ findings is released, an independent technical review by a second forensic analyst must be performed on the DNA test result findings. When a DNA a comparative search on a DNA database produces a DNA match between a known person of interest in a case to cases with no person of interest, the laboratory may ~~on~~ request a second DNA reference sample of the person of interest~~,~~ to defend for retesting. All standard operation procedures, validation reports, and appropriate testing and proficiency test records should be made available to the defense.

3.TOWARDS A RESPONSIBLE USE OF DNA TECHNOLOGY

Utilising forensic DNA technology responsibly involves considering breakthroughs such as next-generation sequencing and genetic phenotyping, which offer extensive information on physical characteristics. Although these technologies provide significant insights, their use must prioritise ethical issues to ensure respect for human privacy and consent. Using direct-to-consumer genetic genotyping to identify family members in criminal investigations must be handled cautiously. Law enforcement use of genealogy databases demonstrates the extensive consequences of an individual's choice regarding their genetic data, impacting both close and distant relatives. DNA phenotyping highlights the abundance of sensitive data included in our genetic code.Personal identification is an essential human entitlement. Every year, millions of people around the world are buried anonymously, depriving several families of closure. Therefore, DNA technology is essential for identifying unidentified human remains (8, 9, 10).It is crucial to balance the requirements of investigations with safeguarding individual rights and family privacy (11). Establish precise regulations and monitoring systems to ensure the ethical use of new technologies, emphasising openness, accountability, and compliance with legal norms. Continual communication among stakeholders such as scientists, politicians, ethicists, and the public is essential for developing ethical practices prioritising scientific integrity and human rights in forensic DNA analysis.

4.PUBLIC TRUST

Public confidence in forensic DNA analysis is crucial for the efficient operation of the criminal justice system (3, 13, 14). Trust relies on transparency, accuracy, and ethical behaviour throughout DNA analysis. This transparency and ethical behaviour involves gathering, analysing, interpreting, and retaining DNA evidence. Moreover, forensic practitioners must guard against and take appropriate measures against bias in the forensic analysis and interpretation of forensic results (13). Thus, forensic laboratories should instead deploy probabilistic genotyping methods in mixture analysis. Law enforcement organisations and forensic laboratories must follow rigorous methods and standards to guarantee the accuracy and trustworthiness of DNA analysis outcomes (3,14). Legislation should regulate forensic science and forensic practitioners' competency and ethical practice (3). Legislation must clearly define from whom DNA buccal samples may be collected, the buccal sample's retention, and forensic DNA profiles for different categories. Building trust also requires accountability measures to address errors or malfeasance immediately. Respecting individual privacy rights and ensuring equitable treatment in managing DNA data are crucial for preserving public confidence (5). Commitment to ethical behaviour, transparency, and responsibility is essential for maintaining public faith in forensic DNA analysis. A regulatory oversight body that monitors legislative and regulatory compliance and the ethical conduct of forensic practitioners is not

an option anymore but rather a necessity (3, 14). Moreover, accurate disclosure regarding the limitations and ambiguities of DNA evidence is vital in regulating public expectations and fostering trust.

5. CONCLUSION

Forensic DNA analysis is crucial in both criminal and non-criminal (human identification) investigations and must be carefully balanced with individual rights, particularly regarding privacy, consent, and ethical standards. Stringent regulation of DNA data management is crucial to prevent misuse and protect privacy. Probabilistic genotyping software improves accuracy in deciphering intricate mixes. To responsibly use DNA technology, one must navigate new technologies while following ethical principles. Transparency, correctness, and ethical behaviour during the analysis process are crucial for building public trust. Regulatory oversight and accountability measures are essential for rectifying mistakes and maintaining equity in DNA data management. The forensic community may maintain scientific integrity and public faith in DNA analysis by promoting ongoing conversation and adhering to ethical principles.

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