Revista Científica del Instituto Nacional de Medicina Legal y Ciencias Forenses de Colombia

https://revistasforenses.medicinalegal.gov.co/index.php/an/about

Editorial

Conducting Research to Ensure Forensic Evidence Is Reliable and Fit for Judicial Decision-Making

Juan Pablo Alzate Granados.

Deputy Director for Scientific Research, Instituto Nacional de Medicina Legal y Ciencias Forenses de Colombia, Bogotá (Colombia).
Correspondence: juan.alzate@medicinalegal.gov.co

Keywords: forensic sciences, applied research, cognitive bias, forensic medicine, reproducibility, quality.

Forensic science operates at a unique intersection in society: where pain demands an explanation, violence leaves traces, and institutions must respond with truth, safeguards, and due process. In this setting, a forensic expert report is not an administrative procedure, but a scientific act with legal and human consequences that, in many cases, are irreversible.

From this perspective, research cannot be regarded as an ancillary activity or an academic luxury. Without scientific research, forensic practice can become a convincing routine, but not necessarily a reliable one. Public confidence in judicial decisions rests not on tradition or institutional authority, but on methods that are sound, transparent, open to evaluation, and capable of revealing their own limitations.

Forensic Research as a Bridge Between the Laboratory and Judicial Decision-Making

For decades, many forensic disciplines expanded "outward": they broadened their coverage, responded to growing demand, became more specialized, and incorporated new technologies. However, this growth did not always progress at the same pace "inward," that is, in terms of empirical support, performance measurement, error-rate estimation, and rigorous assessment of the validity of their inferences.

The scientific literature has clearly indicated that legal and scientific forces are driving forensic sciences toward a paradigm shift: from claims based on assumptions or historical practice to claims supported by measurable evidence (1).

This is not an abstract proposition. A prominent example comes from studies of decision-making in latent fingerprint examination. A large-scale study reported false-positive and false-negative rates in examiner decisions and showed how independent verification can detect errors that do not always emerge during the ordinary course of analysis (2).

Subsequent studies assessed repeatability, understood as the consistency of the same examiner when reassessing a case, and reproducibility, that is, the degree of agreement among different examiners. Their findings showed that a substantial share of variability is concentrated in so-called "borderline" cases: situations in which the latent print is partial or blurred, or contains only a limited number of useful details, making it difficult to determine whether the result should be classified as an identification, an exclusion, or an inconclusive result (3).

In other areas, such as bloodstain pattern analysis, findings calling for scientific humility have also been reported: a study of practicing analysts found significant errors and disagreements among experts, together with evidence of a need to standardize terminology and criteria (4).

Taken together, these findings show that conducting research is not an "additional" activity alongside operations, but the mechanism through which operations become defensible, auditable, and open to improvement. This argument concerns not only latent fingerprint examination but also other pattern-comparison disciplines. The available evidence suggests that variability and bias may also arise in fields with strong foundations in biology, genetics, or chemistry when forensic casework requires selecting tests, interpreting complex results, or deciding whether a finding is sufficiently conclusive (5,6). In forensic genetics, for example, it has been documented that DNA mixture interpretation can produce inconsistent conclusions across analysts and can be affected by contextual information unrelated to the technical examination (7). Similarly, in forensic toxicology, information considered irrelevant to the case has been found to influence both the interpretation of presumptive test results and the selection of tests to be performed (8). This does not mean that these disciplines lack a scientific basis; rather, their soundness also depends on procedures that control contextual information, standardize interpretive decisions, and make sources of uncertainty explicit (5,6).

The Human Factor: Expertise Does Not Eliminate Bias

Another compelling reason to conduct research is that forensic practice is mediated by human decisions. Training, experience, and professional ethics are indispensable, but they do not eliminate cognitive vulnerability. Cognitive science applied to forensic practice has shown that task-irrelevant contextual information can influence expert decisions; in a classic study, forensic experts changed their previous judgments when the context provided about the case was altered (9).

More recently, a systematic review synthesized evidence of biases — particularly confirmation bias — across various forensic disciplines and discussed measures to reduce them, including controlling the order in which information is presented, limiting contextual data, using multiple comparison samples, and replication by analysts who are blinded to prior results (5).

This recognition is not an accusation against forensic experts. Rather, it is a reminder that objectivity is not an individual quality guaranteed once and for all, but the result of institutional processes designed to minimize human bias and make relevant uncertainties visible.

Quality in Forensic Medicine and Forensic Pathology: Research Also Prevents Error

In forensic pathology and forensic medicine, research has an additional value: it can prevent errors before they cause harm to families, judicial proceedings, and institutional credibility. The literature on quality assurance in forensic pathology highlights specific components, including minimum autopsy standards, timeliness of report issuance, peer review, participation in external quality assurance programs, adequate documentation, and reasonable workload limits (10).

Each of these quality components, in turn, raises research questions. It is important to determine what proportion of casework should be peer reviewed to reduce discrepancies cost-effectively, which timeliness indicators correlate with better service to users, and which changes to report formats improve understanding among judicial decision-makers without overinterpreting the evidence. Without applied research, quality programs risk becoming mere checklists; with research, they become institutional learning and verifiable improvement.

Medicolegal Death Investigation Data: How Research Protects the Living

Forensic medicine not only addresses the past — what happened — but can also protect the future — how to prevent it from happening again. In this sense, medicolegal death investigation systems generate data essential to public health and prevention: interpersonal violence, overdoses, road traffic crashes, and other emerging risks. For this reason, it has been emphasized that these data help "the living" by connecting death investigation with public health decisions and evidence-based prevention policies (11).

In any country, and with particular urgency in settings marked by high levels of violence or inequality, research is a strategic function. Forensic research not only produces evidence for judicial proceedings; it can also become a tool for surveillance, prevention, and evidence-based public policy.

A Minimum Applied Research Agenda to Strengthen Practice

Table 1. summarizes a minimum applied research agenda that any forensic institution can adapt to its context.

Table 1. Minimum Applied Research Agenda for Strengthening Forensic Practice

Priority Area	Research Question (Example)	Research Question (Example) Operational Deliverable
Method Validity and Performance	What are the error rate and uncertainty of a technique under real-world casework conditions?	Performance studies, limits of inference, and sample-sufficiency criteria.
Reproducibility and Consistency	When and why do experts disagree? What types of cases account for the greatest variability?	Rules for verification or second review and classification of borderline cases.
Human Factors and Biases	What contextual information increases the risk of bias, and how can that risk be mitigated?	Information management protocols and workflows with context management controls.
Quality, Timeliness, and Service	What changes reduce discrepancies and improve turnaround times without sacrificing rigor?	Smart audits, peer review, and user-centered quality indicators.

Source: Prepared by the author.

Each of these areas can be translated into concrete, measurable, and publishable projects; above all, each can be transformed into verifiable improvements in forensic services.

The discussion of scientific writing in forensic journals reminds us that research and communication are inseparable tasks. An institution that conducts research but does not publish learns late; an institution that publishes without a sound method learns poorly. Therefore, a robust scientific culture in the forensic sciences must be rigorous, because the evidentiary standard requires it; relevant, because real-world problems do not always align with external agendas; collaborative, because forensic challenges are rarely solved within a single discipline; and ethical and transparent, because forensic casework involves people, bodies, families, and judicial proceedings.

The objective is not merely to produce articles, but to produce knowledge capable of solving problems: reducing uncertainty, quantifying limitations, improving reports, strengthening quality, facilitating accountability, and making decisions that depend on forensic evidence more reliable.

Forensic science gains legitimacy not by declaring itself scientific, but by behaving as a science. It requires measuring, comparing, replicating, acknowledging uncertainties, documenting limitations, and correcting when necessary. Research is the path by which evidence becomes not merely persuasive, but reliable; not merely useful at trial, but fit for judicial decision-making and for the consequences that follow from those decisions.

In this way, this issue of Antistio may be read as an invitation to subject forensic practices to the test of evidence, to write about what has been learned, to publish the improvements achieved, and to build a forensic science community that fosters dialogue between Colombia and the world in both directions.

Editorial Note on the Use of AI

For this document, artificial intelligence (AI) was used solely to support language editing — clarity, flow, and minor wording adjustments — under the author's supervision. The reasoning, substantive content, and final selection of references were responsibly reviewed and validated.

References

[1] Saks MJ, Koehler JJ. The coming paradigm shift in forensic identification science. Science. 2005;309:892-5. https://doi.org/10.1126/science.1111565. ↑See page 1

[2] Ulery BT, Hicklin RA, Buscaglia J, Roberts MA. Accuracy and reliability of forensic latent fingerprint decisions. Proc Natl Acad Sci. 2011;108:7733-8. https://doi.org/10.1073/pnas.1018707108. ↑See page 1

[3] Ulery BT, Hicklin RA, Buscaglia J, Roberts MA. Repeatability and reproducibility of decisions by latent fingerprint examiners. PLoS One. 2012;7:e32800. https://doi.org/10.1371/journal.pone.0032800. ↑See page 1

[4] Hicklin RA, Winer KR, Kish PE, Parks CL, Chapman W, Dunagan K, et al. Accuracy and reproducibility of conclusions by forensic bloodstain pattern analysts. Forensic Sci Int. 2021;325:110856. https://doi.org/10.1016/j.forsciint.2021.110856. ↑See page 1

[5] Cooper GS, Meterko V. Cognitive bias research in forensic science: A systematic review. Forensic Sci Int. 2019;297:35-46. https://doi.org/10.1016/j.forsciint.2019.01.016. ↑See page 2

[6] Kaur S. Cognitive and other types of biases affecting forensic evidence: research analysis and expert conclusions. Themis: Research Journal of Justice Studies and Forensic Science. 2022;10(1):Article 8. https://doi.org/10.31979/THEMIS.2022.1008. ↑See page 2

[7] Dror IE, Hampikian G. Subjectivity and bias in forensic DNA mixture interpretation. Sci Justice. 2011;51:204-8. https://doi.org/10.1016/j.scijus.2011.08.004. ↑See page 2

[8] Hamnett HJ, Dror IE. The effect of contextual information on decision-making in forensic toxicology. Forensic Sci Int Synergy. 2020;2:339-48. https://doi.org/10.1016/j.fsisyn.2020.06.003. ↑See page 2

[9] Dror IE, Charlton D, Péron AE. Contextual information renders experts vulnerable to making erroneous identifications. Forensic Sci Int. 2006;156:74-8. https://doi.org/10.1016/j.forsciint.2005.10.017. ↑See page 2

[10] Ong BB, Milne N. Quality assurance in forensic pathology. Malays J Pathol 2009;31:17-22. ↑See page 2

[11] Warner M, Braun PA, Brown PA. Public health impact: How medicolegal death investigation data help the living. Acad Forensic Pathol. 2017;7:xiv-vi. https://doi.org/10.1177/192536211700700405. ↑See page 3