

Report of the Expert Working Group on Human Factors in Forensic DNA Interpretation

Forensic DNA Interpretation and Human factors: Improving Factors Through a Systems Approach

NISTIR 8503 * May 2024

Clint Hughes & Dana Delger





THE PROCESS

How It Gets Made




AGENDA

Introduction to Human Factors

The Process of EWG Reports

Highlights from Past Reports

Key Recommendations



The scientific discipline concerned with the understanding of interactions among humans and other elements of a system.

HUMAN FACTORS



HUMAN FACTORS

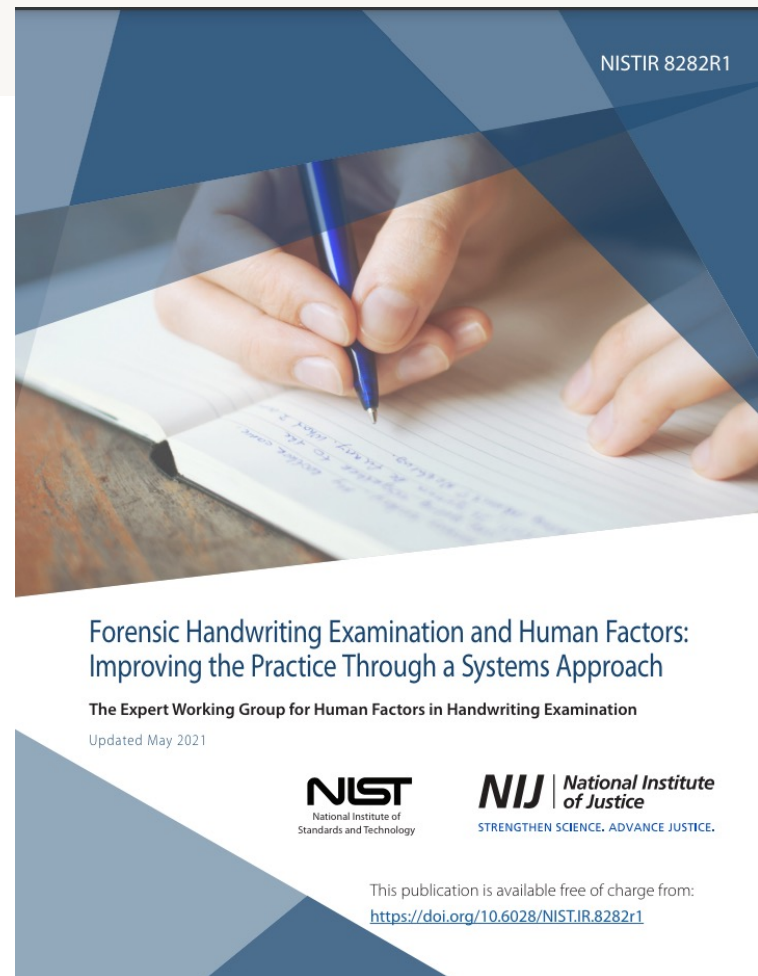
The study of human factors examines interactions between individuals and all other elements of a system—technology, training, procedures, workspaces, the overall environment, resources, institutional culture, and other internal and external factors.

Goal is to conduct **scientific assessments** of the effects of human factors on forensic analyses with the goal of recommending strategies and approaches to improve its **practice** and **reduce the likelihood of errors**

Scientific assessment in this context is an **evaluation of a body of scientific or technical knowledge** that typically synthesizes multiple factual inputs, data, models, assumptions, or **applies best professional judgment to bridge uncertainties** in the information available.

EXPERT WORKING GROUP SERIES ON HUMAN FACTORS IN FORENSIC SCIENCE

Purpose and Goals



WORKING GROUP MEMBERSHIP

- Working group members have diverse backgrounds
 - Forensic practitioners
 - Statisticians
 - Psychologists
 - Researchers
 - Lawyers
 - Professional organizations and other interested parties
- Represents diversity across geographic and scientific backgrounds
- Consensus documents represent many perspectives and compromise

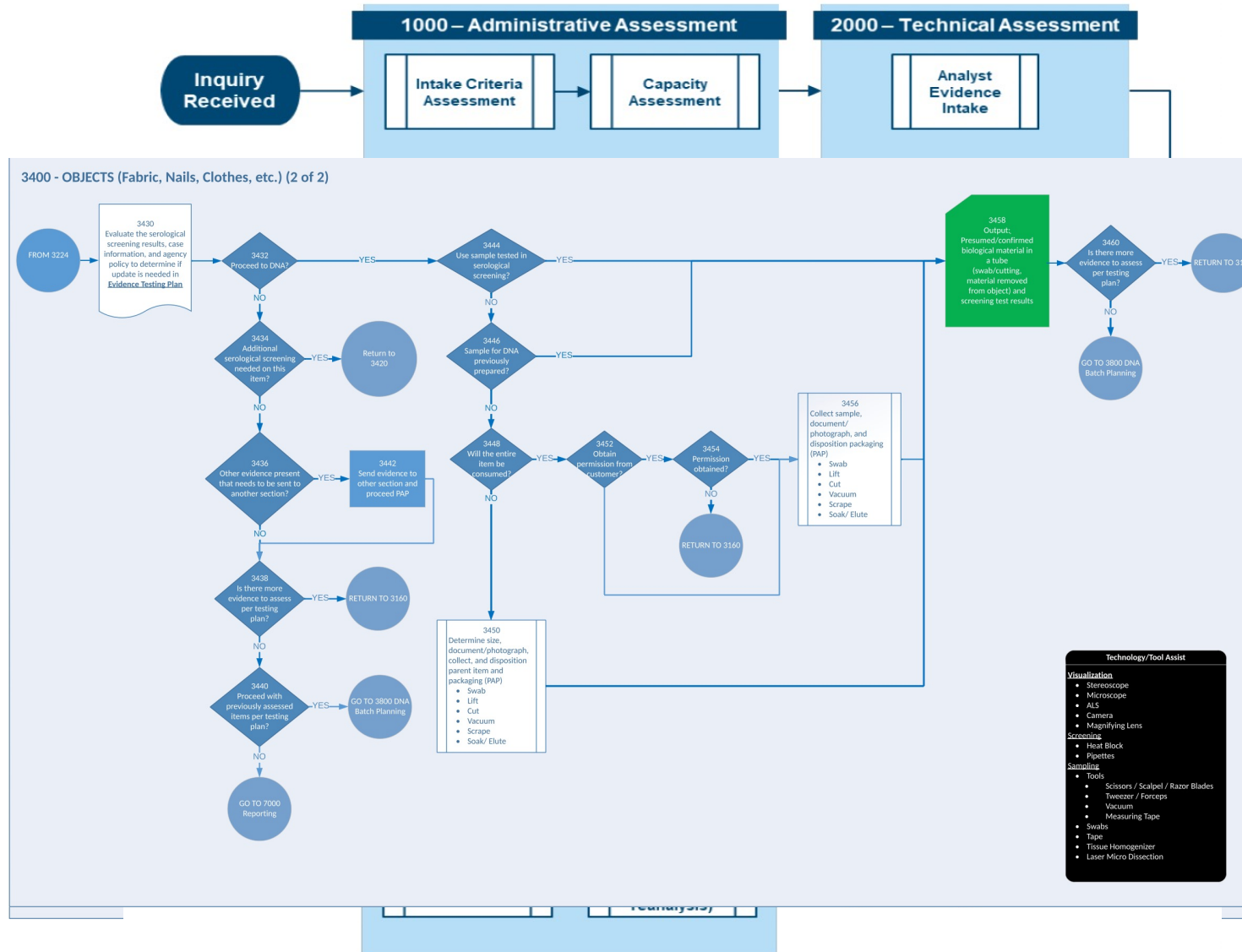
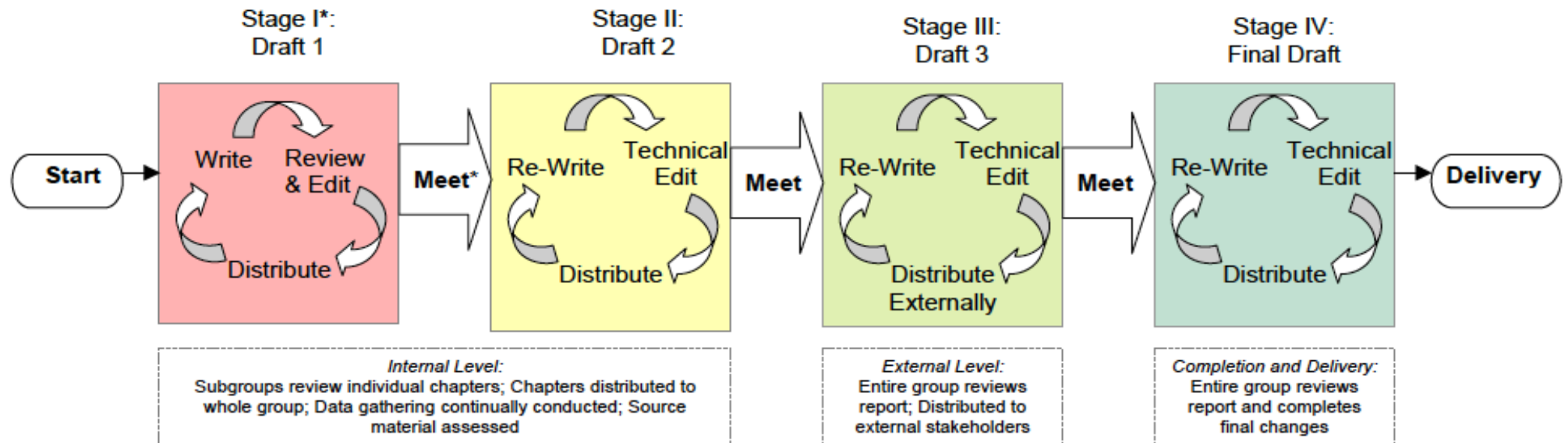


Figure 2.1: Overview of the human forensic DNA analysis process map.

Report Development Process



*At each stage there may be one or two cycles of the writing, review, and distribution of each draft. This can be done either electronically or in person.

**The group must meet and discuss to reach consensus or adjudicate feedback to move the document onto the next stage.

KEY RECOMMENDATIONS AND SHIFTS: HANDWRITING AND LATENT PRINTS

Errors happen

Shift away from identification

Cognitive bias is real



HUMAN FACTORS

in Forensic DNA Interpretation

- **Examine** current policies, procedures, and practices within the field of forensic DNA interpretation to analyze human factors in forensic analyses.
- **Develop** practices based on scientifically sound research to reduce the likelihood of errors in forensic DNA interpretation.
- **Evaluate** various approaches to quantifying measurement uncertainty within forensic DNA interpretation.
- **Publish** findings and recommendations to include future research initiatives.



KEY RECOMMENDATIONS
A Guide For Lawyers



LIMITATIONS IN DNA ANALYSIS

Recommendations on Testimony
And Disclosure

LIMITATIONS IN DNA ANALYSIS

- Report focuses on acknowledging limitations in DNA analysis and better communication of those limitations to factfinders
- A major emphasis is what DNA can do and cannot do and the need for analysts to clarify those limits
- There is a significant emphasis on transparency in communication, largely in ways that benefit the defense

KEY THEMES

Source information \neq how and when DNA was deposited

DNA cannot identify an individual conclusively

DNA is susceptible to error

DNA is not dispositive

LIMITATIONS IN DNA ANALYSIS



Recommendation 5.3: Forensic science service providers should include caveats and limitations in reports containing an evaluation of results considering the source of the DNA. These should make clear that:

- **If any conditioning information used in the calculation changes, a new evaluation is needed.**
- **The evaluation of the DNA comparison cannot conclusively identify an individual as the source of the DNA.**
- **The report does not provide any information about how or when the DNA was deposited.**

A mixed DNA profile controversy revisited

Tim Kalafut PhD¹ | Simone Pugh MS² | Peter Gill PhD^{3,4} | Sarah Abbas MSc^{5,6} |
Marie Semaan MSc⁵ | Issam Mansour PhD⁵ | James Curran PhD⁷ | Jo-Anne Bright PhD⁸ |
Tacha Hicks PhD^{9,10} | Richard Wivell BSc (hons)⁸ | John Buckleton DSc^{7,8}

TABLE 6 Unconditioned LR_{u/uu} for Experiment 4 (4:1 low-level mixture) using STRmix™ and data from El Andari et al. (6) and $\theta = 0.01$

<i>i</i>	P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	P ₈
LR _{u/uu}	1.46 × 10 ¹⁰	9.14 × 10 ¹¹	5.86 × 10 ²³	1.58 × 10 ¹¹	7.40 × 10 ⁸	4.61 × 10 ¹¹	1.80 × 10 ¹⁰	4.07 × 10 ¹²

Note: All eight references give values that support the first proposition compared to the alternative when no conditioning profiles are used.

**4.07 Trillion
(2.86E+12)**

LIMITATIONS IN TESTIMONY



Recommendation 6.2: When explaining the nature of DNA analysis during testimony, the DNA expert should address common misconceptions and state the limitations of the analysis. At a minimum, the DNA expert should address the following main points:

- **The DNA results are only part of the overall case.**
- **Errors can occur in any human process, including DNA analysis.**
- **The evaluation of the DNA comparison cannot conclusively identify an individual as the source of the DNA.**
- **DNA analysts cannot provide any information on how or when DNA was deposited in a particular case, based on a report considering only the source of the DNA.**

PRE-TRIAL MEETINGS AND DISCLOSURE



Recommendation 6.1: When legally permissible and possible, the testifying DNA analyst and the legal professionals involved in the case should confer prior to the trial to gain a shared understanding of the report, propositions, correct language for describing the value of the results, and what the results mean and do not mean.

- In jurisdictions where pre-trial meetings with state expert are either not allowed or not routine, these recommendations and accompanying text might be leverageable.
- Note also Rec. 5.4: Forensic science service providers should offer training to criminal justice partners on the caveats and limitations of DNA testing so that results are properly incorporated along with other information in the case.

Likelihood Ratios

- Likelihood ratios are not a measurement!
- There is no true LR
- Given those facts, report says that “concepts like ‘precision’ and ‘accuracy’ are not appropriate in the LR framework”
- Fact finders may not understand this and overly rely on pinpoint values



RECOMMENDATION 4.2

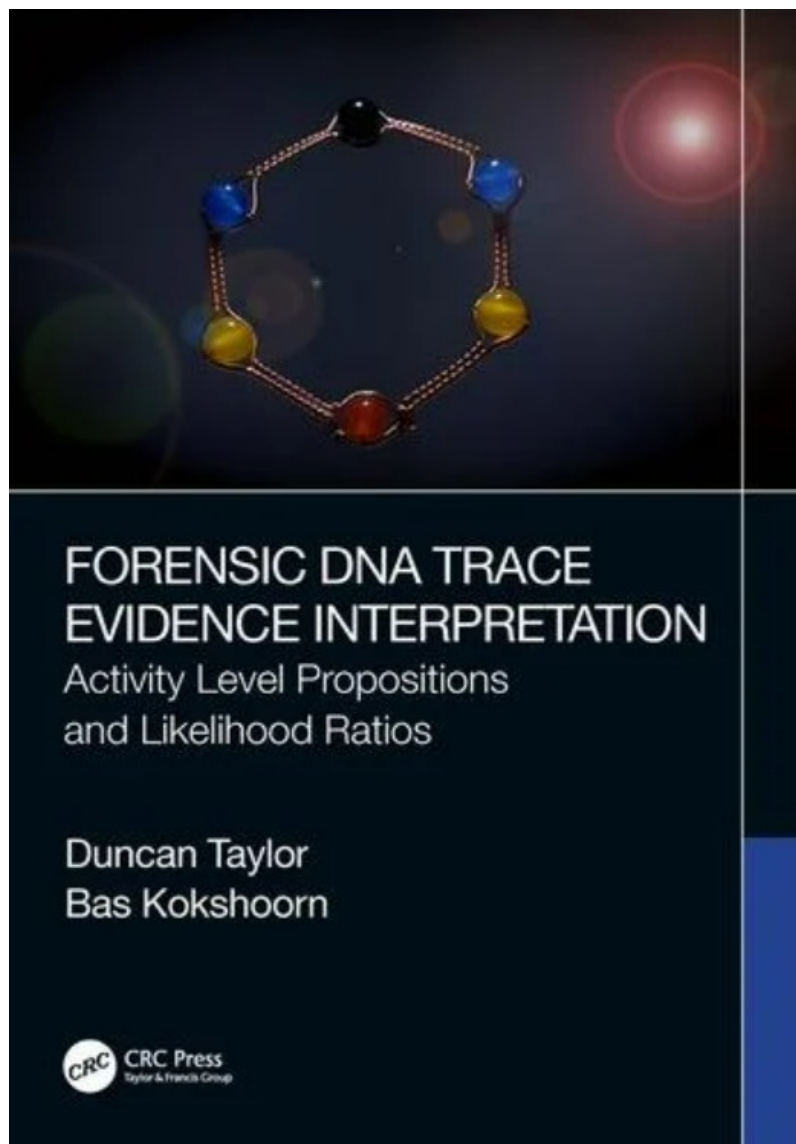
“To avoid conveying an unsupported level of precision, forensic science service providers should express likelihood ratios as an order of magnitude or to one significant figure.”

For example, if an LR of 10,256.32 was computed, the analyst could report that the results are of the order of 10,000 times more probable under H1 than under H2.



RECOMMENDATION 4.3

“To avoid presenting likelihood ratios that are larger than can be supported by currently available research and to assist in the comprehension of analyses that result in very large likelihood ratios (or very small Random Match Probabilities) with respect to unrelated individuals, forensic science service providers should implement a reporting cap of 1 billion (or 1 in 1 billion), or an alternative value that can be justified by research.*” [Dissent]



TRANSFER

How and **When** Questions

DNA TRANSFER

- In their training to learn STR benchwork at the lab, analysts do not get the training to confer activity-level expertise.
- Yet it's **still** common for analysts to answer questions about possibility or probability of direct and indirect transfer without validated methods, education, evidence of competency, or quality assurance systems within the lab
- Report raises concerns about such testimony:
 - Often raised on the stand
 - Need to recall literature
 - Lack of technical review
 - Concern factfinder will conflate DNA comparison with activity level



TRANSFERRING SCHOOLS

Recommendation 7.3: “The federal government should fund collaborative efforts to review the foundations and principles of evaluating biological results when considering alleged activities. Based on the findings, additional fiscal support should be available to educate and guide DNA and legal communities on the review, research, selection, and validation of appropriate methods to account for DNA transfer, persistence, prevalence, and recovery when assessing biological results.”

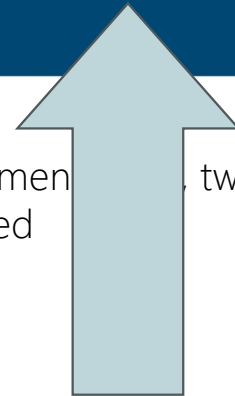
TRANSFER



Recommendation 7.1: DNA analysts should not opine about the possibility or probability of direct or indirect transfer having occurred in a case.*

The possibility or probability of something occurring "in a case" is not the same as the scientific possibility of transfer generally.

*not a consensus recommendation, two working group members dissented



HOW/WHEN VS. WHO



Recommendation 7.2: The evaluation of DNA results given “how” and “when” questions is distinct from the evaluation of DNA results given “who” questions. In order to develop policies and practices on how DNA analysts should respond appropriately to questions about how and when DNA was deposited in a particular case, forensic science service providers should consult professional guidance documents and experts who understand issues related to transfer and persistence. These policies and practices should require DNA analysts to be appropriately trained to respond to such questions.*

Who is an appropriate expert here?



Contents lists available at ScienceDirect

Forensic Science International: Genetics Supplement Series

journal homepage: www.elsevier.com/locate/figss



Need for dedicated training, competency assessment, authorisations and ongoing proficiency testing for those addressing DNA transfer issues



Roland A.H. van Oorschot^{a,b,*}, Bianca Szkuta^{a,c}, Kaye N. Ballantyne^{a,d}, Mariya Goray^e

^a Office of the Chief Forensic Scientist, Victoria Police Forensic Services Department, Macleod, Australia

^b School of Molecular Sciences, College of Science, Health and Engineering, La Trobe University, Bundoora, Australia

^c School of Life and Environmental Sciences, Deakin University, Geelong, Australia

^d School of Psychology and Public Health, La Trobe University, Bundoora, Australia

^e Biometric Services Division, Victoria Police Forensic Services Department, Macleod, Australia

“Of the 18 responses per participant, the percent of correct responses by any participant ranged from 11 to 67% (average of 42%).”



World View | Published: 28 October 2015

Forensic DNA evidence is not infallible

[Cynthia M. Cale](#) 



J Forensic Sci, January 2016, Vol. 61, No. 1
doi: 10.1111/1556-4029.12894
Available online at: onlinelibrary.wiley.com

TECHNICAL NOTE

CRIMINALISTICS

Cynthia M. Cale,^{1,2} B.S.; Madison E. Earll,² M.S.; Krista E. Latham,² Ph.D.; and Gay L. Bush,¹ Ph.D.

Could Secondary DNA Transfer Falsely Place Someone at the Scene of a Crime?*,†

Bas Kokshoorn,¹ Ph.D.; Bart Aarts,¹ Ph.D.; Ricky Ansell,^{2,3} Ph.D.; Louise McKenna,⁴ Ph.D.; Edward Connolly,⁴ Ph.D.; Weine Drotz,² M.Sc.; and Ate D. Kloosterman,^{1,5} Ph.D.





**TEXAS FORENSIC
SCIENCE COMMISSION**
Justice Through Science

**FINAL REPORT ON COMPLAINT NO. 23.67;
TIFFANY ROY; (TIMOTHY KALAFUT, PH.D.;
EVALUATION OF BIOLOGICAL/DNA RESULTS
GIVEN ACTIVITY LEVEL PROPOSITIONS)**

July 26, 2024

The background of the report cover features a large, semi-transparent seal of the State of Texas on the left, which includes a five-pointed star and the words "STATE OF TEXAS". To the right of the seal is an aerial photograph of Austin, Texas, showing the state capitol building and surrounding city buildings under a clear sky.

DNA cannot conclusively identify an individual as its source in part because that determination involves consideration of the entire case.

By the same token, whether or not direct or indirect transfer was *possible* in a particular case involves a consideration of all the evidence, most of which the analyst doesn't know (and we don't always want them to).





TRANSFER: CARVEOUTS AND CAVEATS

- Nothing in the recommendations should prevent acknowledgment of the scientific evidence of the possibility of transfer in general
- Likewise, the existence of particular studies could be discussed (maybe a subject for pretrial meetings)
- Report does not say such testimony will never be feasible.
- Activity level testimony is regularly presented in Europe currently – mixed bag for the defense



INTERSECTION WITH PROPOSITIONS

Recommendation 3.1: To promote balance and transparency in DNA analysis, forensic science service providers should apply the “principles of interpretation” and should understand the “hierarchy of propositions.”

Table 3.1: Examples of pairs of mutually exclusive propositions at the source and activity levels of the hierarchy of propositions

Level	Question/Issue	Results	Example of Pairs of Propositions
Activity	Did the POI perform the activity?	<ul style="list-style-type: none"> • Presence/absence of DNA at different locations • Quantity/quality of the DNA (DNA profiling comparison) • Presumptive tests • Multiple traces from the same activity 	<ul style="list-style-type: none"> • Mr. A and Ms. B had penile-vaginal intercourse. • Mr. A and Ms. B only partook in social activities as described in the case information. <hr/> <ul style="list-style-type: none"> • Mr. Smith was the driver, and Mr. Jones was the passenger at the relevant time. • Mr. Jones was the driver, and Mr. Smith was the passenger at the relevant time.
Source	Is the POI the source of the biological material?	<ul style="list-style-type: none"> • DNA profiling comparison 	<ul style="list-style-type: none"> • Mr. A is the source of the blood. • An unknown individual is the source of the blood.
Sub-Source	Is the POI the source of the DNA?		<ul style="list-style-type: none"> • Mr. A is the source of the DNA. • An unknown individual is the source of the DNA.
Sub-Sub-Source	Is the POI the source of part of the mixture?		<ul style="list-style-type: none"> • Mr. A is the major contributor of the DNA mixture. • An unknown individual is the major contributor of the DNA mixture.



ORIGIN OF REC. 3.1

- Recommendation also grows out of report's recommendations to apply principles of interpretation:
- To be balanced, the analyst should consider at least two mutually exclusive propositions when assessing the value of biological results.
- Relevant case information should be used in formulating the issues that forensic DNA analysis can provide insight to
- Analysts should assign the probability of the findings, not the probability of the (alleged) facts

OUTER LIMITS

Bounds in DNA



RELATEDNESS

- Relatedness is a problem, even in PGS systems
- “Non-contributors who are relatives of true contributors can produce **high LRs** when considering propositions such as (1) the [defendant] and two unknown individuals are the source of the DNA mixture, or (2) three unknown individuals are [the source]”
- LRs are not exhaustive, so best explanation for results might be a different proposition (i.e., a relative)
- Low-level DNA with high drop out heightens this risk

PAPER

Criminalistics

A mixed DNA profile controversy revisited

Tim Kalafut PhD¹ | Simone Pugh MS² | Peter Gill PhD^{3,4} | Sarah Abbas MSc^{5,6} |
Marie Semaan MSc⁵ | Issam Mansour PhD⁵ | James Curran PhD⁷ | Jo-Anne Bright PhD⁸ |
Tacha Hicks PhD^{9,10} | Richard Wivell BSc (hons)⁸ | John Buckleton DSc^{7,8}

A mixed DNA profile controversy revisited

Tim Kalafut PhD¹ | Simone Pugh MS² | Peter Gill PhD^{3,4} | Sarah Abbas MSc^{5,6} |
Marie Semaan MSc⁵ | Issam Mansour PhD⁵ | James Curran PhD⁷ | Jo-Anne Bright PhD⁸ |
Tacha Hicks PhD^{9,10} | Richard Wivell BSc (hons)⁸ | John Buckleton DSc^{7,8}

TABLE 6 Unconditioned LR_{u/uu} for Experiment 4 (4:1 low-level mixture) using STRmix™ and data from El Andari et al. (6) and $\theta = 0.01$

<i>i</i>	P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	P ₈
LR _{u/uu}	1.46 × 10 ¹⁰	9.14 × 10 ¹¹	5.86 × 10 ²³	1.58 × 10 ¹¹	7.40 × 10 ⁸	4.61 × 10 ¹¹	1.80 × 10 ¹⁰	4.07 × 10 ¹²

Note: All eight references give values that support the first proposition compared to the alternative when no conditioning profiles are used.

**4.07 Trillion
(2.86E+12)**



NO RESULTS ON THE FLY

Recommendation 6.3: DNA experts should not perform new evaluations of the DNA results on the witness stand because these evaluations have not been reviewed, reported, or disclosed to all parties.



SETTING THE GROUND RULES

Recommendation 3.8: Labs' SOPs "should provide criteria for assessing and documenting when a probabilistic genotyping interpretation should be rejected."

THANK YOU!

dana.delger@gmail.com

chughes@bds.org