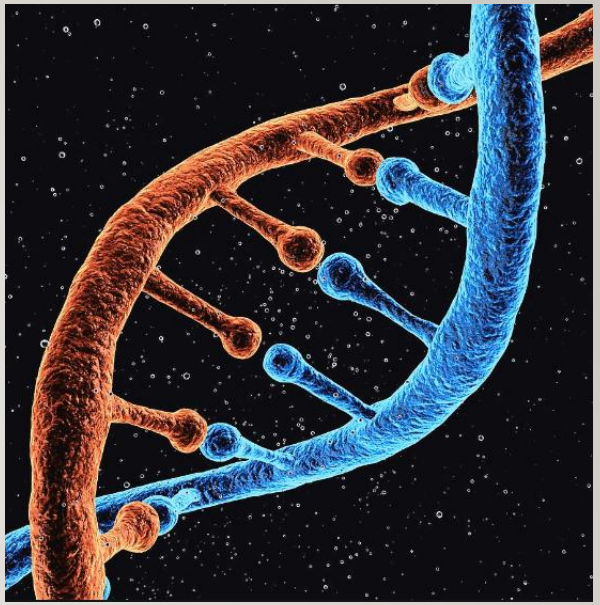
COMMUNICATING FORENSIC BIOLOGY FINDINGS



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*Disclaimer- most, if not all, of the content of this presentation are my own opinions!

CFF – BIOLOGY POINTS TO COVER:

1) HIERARCHY OF PROPOSITIONS: what is the issue and can we help?
2) COMMUNICATING BIOLOGICAL RESULTS IN THE US
   - Serology /biological screening (is it blood? semen?)
   - DNA results/comparisons (is POI a contributor or not?)
   - Numbers? Words? Both?
3) STRATEGIES FOR COMMUNICATION

TYPICAL QUESTIONS THAT FORENSIC BIOLOGY MAY BE ABLE TO ***HELP*** WITH

1) What is the nature of this material?
   - Blood?
   - Semen?
   - Saliva?
   - Limited: feces/urine
2) Is there detectable DNA on an item?
3) Is the POI contributing DNA to the item or not?

We often cannot directly answer these questions

HIERARCHY OF PROPOSITIONS (LATE 90s)

LEVEL	QUESTION/ISSUE	RESULTS	EXAMPLE PROPOSITIONS
Offense	Is the POI the offender?		• POI sexually assaulted Ms. A • POI had nothing to do with the assault of Ms. A
Activity	Did the POI perform the activity?	• Presence/absence of DNA • Quantity/quality of DNA • DNA profile comparison (does not always have to be uncontested) • Presumptive tests • Multiple traces	• POI digitally penetrated the vagina of Ms. A • POI and Ms. A only had social interactions
Source 	Is the POI the source of the biological material (such as blood or semen)?	• DNA profiling comparison • Obvious nature of the material (large bloodstains, millions sperm heads, bone)	• The blood came from POI • The blood came from some other man

Citation: Cook et al. A hierarchy of propositions: deciding which level to address in casework. Science & Justice 1998; 38: 231–239.

HIERARCHY OF PROPOSITIONS – EXPANDED "SOURCE"

LEVEL	QUESTION/ISSUE	RESULTS	EXAMPLE PROPOSITIONS
Source	Is the POI the source of the biological material (such as blood, semen)?	• DNA profile comparison	• POI is source of the bloodstain • An unknown, unrelated person is the source of the bloodstain
Sub-Source	Is the POI the source of the DNA?		• POI is source of the DNA • An unknown, unrelated person is the source of the DNA
Sub-sub-source	Is the POI the source of a component of the DNA?		• POI is the major contributor of the DNA mixture • An unknown, unrelated person is the major contributor of the DNA mixture

Why? – Increased sensitivity of DNA kits (+ more loci, highly discriminating)
No longer just testing sources where biological source is obvious – we are assessing ***DNA TRACES***

Should we then consider transfer, persistence, and background?

Citation: Hicks, T.; Buckleton, J.; Castella, V.; Evett, I.; Jackson, G. A Logical Framework for Forensic DNA Interpretation. Genes 2022, 13, 957. https://doi.org/10.3390/genes13060957

FORMULATING PROPOSITIONS (typically sub-source)

- Task-relevant case information (framework of circumstances)
  - Where is the sample from?
  - Are there any sources of expected DNA (intimate, prevalence of owner/user DNA)
  - Are there potential relatives that could have expected DNA
    - Can they be typed? Conditioning can help….
  - Is a relative of the POI an alleged alternative POI?!
    - Will we know this information?

- Ideally this is done **prior to** assessing evidence to avoid findings-led propositions

CURRENT STATE OF COMMUNICATING BIOLOGICAL SCREENING RESULTS IN THE US

- Tests that give information about the nature of the material (blood? semen?)
- Some tests call themselves 'confirmatory' – but this is a misnomer
- These tests are variably reported such as positive, weak positive, negative
- Sometimes as "identification" of the tested biological material - appears as "facts"
  - Instead of communicating the value of the findings (by say, considering false positives or negatives, appearance of the stain, etc)
- The factfinder is often left to correlate these findings with the DNA results

CURRENT STATE OF COMMUNICATING DNA RESULTS IN THE US: PGS/LRs

The focus of a LR is on the results (NOT on the propositions!)

- Software assisted method to discern DNA profiles and provide value to the comparison
- Two primary software used in the US* that help separate DNA mixtures
  - STRmix™ being used by more than 80 organizations in the US (as of 1/11/2024)[1]
  - TrueAllele® - 10 user labs[2]
- Software help discern profiles (mixtures) and also assign Likelihood Ratio values for DNA comparisons
  - Differ on user inputs (NOC, thresholds) and some modelling
  - Differ on how an LR is communicated

But…what about "exclusions"?

*Approximately 400 publicly funded laboratories https://bjs.ojp.gov/funding/awards/15pbjs-23-gk-00836-bjsb - estimated ~220 U.S. DNA labs https://le.fbi.gov/science-and-lab/biometrics-and-fingerprints/codis/codis-ndis-statistics

1: https://www.strmix.com/news/strmix-has-produced-dna-evidence-in-more-than-530000-criminal-cases-worldwide/

2: Defeating opposition experts: winning with science (cybgen.com)

CURRENT STATE OF COMMUNICATING DNA RESULTS IN THE US: MANUAL METHODS

- Use of terms to convey the similarity between profiles from evidence and people
  1. Similar? "match" "included" "cannot be excluded"
  2. Not sure? "inconclusive"
  3. Not similar? "excluded" "cannot be included"
- Use of statistics is typically provided if "similarity" observed. Only expresses the rarity of the unknown evidentiary profile is (CPI/RMP etc)
- Sometimes conclusions about "source" were/are drawn within a 'reasonable degree of scientific certainty.'

Lacks the balance of LR framework

COMMUNICATING THE VALUE OF DNA COMPARISONS TO THE END-USERS / FACTFINDER…

- Complex scientific topics can be challenging to convey - lots of jargon and can be difficult to describe our process and testing in a way that is easily digestible in a short period of time
- ***Numbers are hard***
  - Any statistical concept is going to be difficult to communicate to lay persons
  - This misunderstanding did not improve with the transition to likelihood ratio framework
  - Common fallacies associated with expressing evidence value numerically
    - By the speaker and the end-user
    - Attaching a probability to a proposition (whether RMP/LRs)
    - Source attributions (rarity does not equal unique)

COMMUNICATING LRs TO THE END-USERS / FACTFINDER… TACKLING NUMERACY ISSUES #1: **CLEARLY STATE THE LIMITATIONS!!!**

What DNA CANNOT help with!

1. Difficult to attribute a profile (or portion) to a biological material ('cellular source')
2. DNA profile comparisons only ***help*** to address WHOSE DNA may or may not be detected.
   - No conclusions about "identity" or "source attribution" can be supported by an evaluation or the magnitude of the LR
   - DNA comparison results should be viewed as one part of the puzzle
3. It is crucial that it is understood that a LR assigned for a DNA comparison cannot be carried up to a question about an activity.
   - Actions? Timing? Motives?
   - The value of the evidence given sub-source level propositions has no meaning in that context (recall the hierarchy).

HUMAN FACTORS REPORT: TESTIMONY CHAPTER

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.

Expert Working Group on Human Factors in Forensic DNA Interpretation (2024). Forensic DNA Interpretation and Human Factors: Improving Practice Through a Systems Approach. National Institute of Standards and Technology, Gaithersburg, MD, NIST IR 8503. https://doi.org/10.6028/NIST.IR.8503

COMMUNICATING TO THE END-USERS / FACTFINDER… TACKLING NUMERACY ISSUES #2: **CONSIDER CAPPING THE LR?**

- Can a cap to the LR prevent some common misconceptions or cognitive fallacies associated with extremely large numbers?
  - Something smaller than the world's population for communication/comprehension
  - Impact of hearing numbers never heard before (octillions?) - will it overshadow other evidence?
  - Do we need such large values to *adequately* convey the strength of the comparison?
- No recent studies on larger 20+ locus kits- but the studies done support **1 billion** as cap (if considering an individual unrelated to the POI)
  - There are many different "caps" though … so it seems to be a matter of preference and policy as well
    - UK, Swiss (1 billion); Australia (100 billion); Denmark (1 million)

COMMUNICATING TO THE END-USERS / FACTFINDER… TACKLING NUMERACY ISSUES #3: **USE VERBAL EQUIVALENTS ??**

- There are many scales - which one is merely a matter of choice, convention, or consensus.

WORDS ARE HARD, TOO!! They mean different things to different people.

- No special "DNA" scale - should work across disciplines (LR=1,000 same whether DNA or glass)
- Verbal qualifiers are only applied after the numerical LR value is assigned. These terms should not stand alone or replace the communication of the LR value.
- Verbal qualifiers should reference both propositions by conveying the support the DNA results provide for one proposition versus the other.
- Many verbal scales stop at an LR of 1 million. Once the LR exceeds (or goes below if the results provide support for H2 vs H1) it becomes difficult to find more words that convey additional meaning [Extremely very strong support ??!!!]

COMMUNICATING TO THE END-USERS / FACTFINDER… TACKLING NUMERACY ISSUES #3: **EXAMPLE VERBAL EQUIVALENTS**

LR for H_p Support and 1/LR for H_d Support	Verbal Qualifier
1	Uninformative
2 – 99	Limited Support
100 – 9,999	Moderate Support
10,000 – 999,999	Strong Support
≥ 1,000,000	Very Strong Support

Scientific Working Group on DNA Analysis Methods (SWGDAM). Recommendations of the SWGDAM Ad Hoc Working Group on Genotyping Results Reported as Likelihood Ratios. 2018. https://www.swgdam.org/_files/ugd/4344b0_dd5221694d1448588dcd0937738c9e46.pdf

LR	Verbal Communication
> 10,000	This support is qualified as *extremely strong*.
> 1000 – 10,000	This support is qualified as *very strong*.
> 100 – 1000	This support is qualified as *strong*.
> 10 – 100	This support is qualified as *moderate*.
> 1 – 10	This support is qualified as *weak* or *limited*.[250]
1	The results support neither proposition. This support is qualified as *null*.

Marquis R, Biedermann A, Cadola L, Champod C, Gueissaz L, Massonnet G, Mazzella WD, Taroni F, Hicks T. Discussion on How to Implement a Verbal Scale in a Forensic Laboratory: Benefits, Pitfalls and Suggestions to Avoid Misunderstandings. Science & Justice. 2016; 56(5):364-70. doi:10.1016/j.scijus.2016.05.009

COMMUNICATING TO THE END-USERS / FACTFINDER… SOLUTIONS?

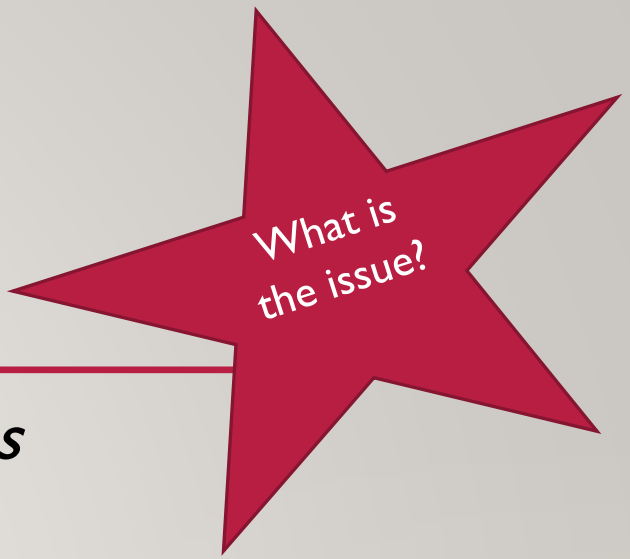
- EDUCATION: How do we/can we educate our end-users
- This differs on setting:
  - Investigators, lawyers
    - Our results are being used without us often (plea deals) – are they properly understood?
  - Factfinders
- Can we find better methods to convey our results in court
  - Starting with the end? (thank you Julie Burrill)
- How we speak matters – but how much? Can we study this in a real setting?
  - Jargon, confidence, trust
  - Speaking like a real person

THE END

CRITERIA FOR REASONING WHEN THERE IS UNCERTAINTY …

- **Balance:** Assessing the evidence in light of clearly defined competing views.
- **Transparency:** Clear delineation of the assumptions and data relied on.
- **Robust:** Can the reasoning stand up to scrutiny? Is the evaluation repeatable?
- **Logic:** Is the reasoning coherent / does it make sense? Are the inferences based upon the results?

PRINCIPLES OF INTERPRETATION

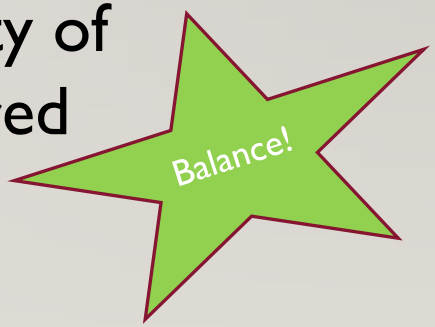


1. Interpretations take place in a *framework of circumstances*

*2. A*t least two competing propositions must be considered

3. Analysts must assign the probability of the (results/findings) – NOT of the alleged fact (e.g., who the source of the DNA is, what activity happened)

4. The value of the findings is expressed by the ratio of the probability of the findings given the case information and the propositions considered (LR)



LIKELIHOOD RATIOS - DNA COMPARISONS

STAYING IN OUR LANE = TALK ABOUT RESULTS

- How we assess the similarity/differences between a reference and unknown profile
- Provides value to the DNA comparison
- Balanced and flexible – can evaluate the DNA results given two scenarios
  - The scenarios state the sources of DNA (POI vs. unknown)
  - May need to consider an individual related to the defendant?
  - May need to consider varying propositions if there are multiple defendants?
- When communicating the LR – the value of the DNA results must be stated in respect to the scenarios considered:
  - The DNA profile is 1 million times more likely to be observed if (scenario 1) than if (scenario 2).

Balance = 2 propositions!

EXTRA SLIDES – TPPR/ACTIVITY LEVEL PROPOSITIONS

EVOLUTION OF DNA TECHNOLOGY: SENSITIVITY

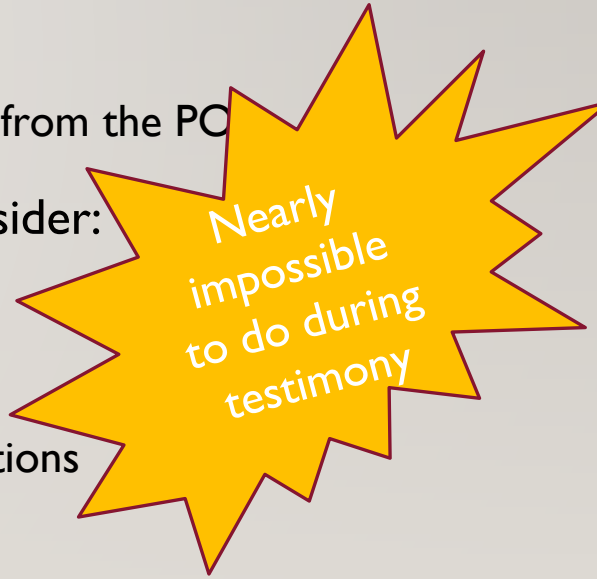
- The ability to detect genetic information has evolved significantly since inception
- Used to be very large visible bloodstains or semen from sexual assaults
- Now – we regularly test firearms, steering wheels, and spent shell casings because we can detect very small amounts ("trace") of DNA.
- Naturally, this leads to questions that other trace disciplines have had to deal with for a long time – with material this small and transient – the "***relevance***" or how or when the DNA got there is more important.

IT'S NOT JUST "TRANSFER"

- Implied in "transfer" is often whether it was "direct" or "indirect"
  - These statements imply an action. Is this DNA there because POI touched it – or because they hung out with a friend (who touched it)?
- Persistence: Expected loss of DNA over time (considerations of timing, nature of material)
- Prevalence: Expected DNA from individuals (your DNA on your own steering wheel)
- Recovery: Methods used to collect and detect DNA profiles (swabs/tape lift, old vs. new kits)
- Background: DNA present from unknown persons for unknown reasons
- Contamination: DNA from POI not from alleged actions but from scene/lab problems

LIMITATION REMINDER

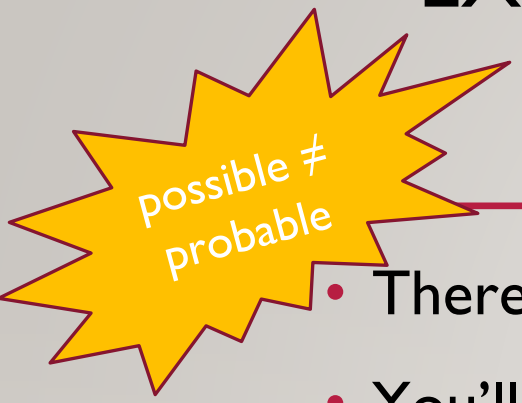
- The DNA comparisons we perform at KCPCL – and their corresponding value – do not address these transfer questions.
- Once the questions move from "who" to "how or when" – it can be challenging to ensure that the (large?) LR value doesn't get carried up.
  - If these questions are being asked, typically everyone is agreeing that the DNA is from the PO
- Recall hierarchy slide – there are more factors than the DNA profiles to consider:
  - Biological screening tests (blood, semen, saliva)
  - Quantity/quality of profiles (how much and the contribution of DNA)
  - Published or in house data about probability of recovering DNA given *specific* actions
    - All the criteria on previous slide



WHY DON'T WE DO THIS EVALUATION THEN?

- In depth education, training, competency, building an entire QA program to support **laboratory-based** interpretations and reporting for disclosure.
  - Very limited training opportunities– as in nothing sufficient in US. University of Lausanne
- This is challenging and new to the U.S.'s thinking (STRmix 10+ years ago).
- Consideration of resources – not every case needs this, but the training needed is considerable.
- Due to the challenge- many people are still resorting to saying statements that are not appropriate given our current understanding:
  - Direct transfer is more likely than indirect
  - Sure, that is possible or one of many possibilities

WHY WE DON'T TESTIFY TO "POSSIBILITIES" AND EXPLANATIONS



- There is an important distinction between "possible" and "probable"
- You'll notice with DNA comparisons we don't state it's possible …. We provide a value of the comparison (this is based on probabilities)
- Typically we are only asked about possibilities when it pertains to questions about how or when the DNA may have been transferred to the item in question
- Possible is not the same as probable (fair coin heads vs. lottery)

WHY WE DON'T TESTIFY TO "POSSIBILITIES" AND EXPLANATIONS

Sufficient facts or data during testimony?

Reliably applied during testimony (no quality process)?

- It is a direct comment on what happened (we do not know this…)
- Possible = speculative, has no inherent value
- It is very difficult to justify "possible" with facts or data – if you could- then you should be doing an evaluation that considers "how possible" – with probabilities
- Explanations = justifying your results once you know them (this is not great logic – anything will work here!)
- May mislead the jury about the strength of the DNA results (over or under value)
- We have aimed to **stay in our lane** of expertise, these questions require a different level of training and authorization