Reporting LR - principles

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Hypothesis setting & verbalizing Likelihood Ratios

- Formulating propositions
- Hierarchy of propositions
- Communicating LRs
Setting propositions

• Some useful principles

  – Propositions should be mutually exclusive
  – Propositions should help the Court address the issue of interest
  – Propositions should be (close to) exhaustive
Setting propositions

• The prosecution proposition \((H_p)\) is usually known

• In an adversarial environment the defence are under no requirement to offer a proposition and often they do not

• If the defence stance is available that can be selected, if not, a sensible proposition consistent with the best defence can be chosen
Setting propositions

• Set based on *relevant* case information, including
  – Alleged activities, location of scene, consensual partners
• Ignore (actually do not want) irrelevant detail, including
  – Prior convictions, motive, other forensic evidence
  – Responsibility of judge/jury to evaluate
Hierarchy of propositions

1. Source
   - e.g. $H_p$ “The semen came from the POI”

2. Activity
   - e.g. $H_p$ “The POI had intercourse with the complainant”

3. Offence
   - Guilt or innocence. e.g. $H_p$ “The suspect raped the victim”

- e.g. $H_p$ “The DNA in the sample came from the POI”
The **offense level** is usually not the realm of the forensic scientist. This is for the court to decide based on all the available information presented.

There may be occasions when a reporting scientist can address the **activity level**, based on their experience and available literature.

In some instances it may be possible to step up to body fluid attribution & hence report at the **source level**

A DNA reporting analyst will spend most of their time at the **sub-source level**
Transition from sub-source to activity

- In practice many lines of questioning concede the source of the DNA and instead focus on transfer & persistence

- Should both parties agree the DNA came from an individual then the LR at (sub) source level is no longer relevant
Hierarchy of propositions

Proposition settings exercise
Example 1

- Scenario: a “Peeping Tom” is discovered looking into a house one night. The police are called and find a single cigarette butt under the window where the incident occurred.
- Single source profile from a cigarette butt
- One person of interest (POI), reference corresponds with profile from cigarette butt
Prosecutor: The evidence came from the POI.

Defense: The evidence came from an unknown person unrelated to the POI.
$H_p$: POI
$H_d$: Unknown
Example 2

• Scenario: A complainant calls 911 to report a sexual assault in her home. She is taken to a hospital where a SA Nurse collects an intimate swab from the complainant.

• A POI is identified from the investigation

• The profile is fully explained by a mixture of C and POI
Example 2

• An intimate swab from the Complainant

• Profile is fully explained by mixing of C and POI’s DNA

• Direction of transfer vital
  – $H_p$: Complainant + POI
  – $H_d$: Complainant + Unknown
Example 3

- Scenario: Assault male on female.
- A POI is identified from the investigation
- Mixed profile on underwear of POI. The profile is fully explained by a mixture of C and POI
Example 3

- Underwear of POI
- Profile is fully explained by mixing of C and POI’s DNA
- Direction of transfer vital
  - $H_p$: Complainant + POI
  - $H_d$: POI + Unknown
Example 5

• Someone has been throwing Molotov cocktails at random cars all over the county. An unexploded container is found in the street, and a 2 person mixture is developed from the evidence.

• Two persons of interest are arrested.
Example 5

\[ H_p: \text{POI}(1) + \text{POI}(2) \]
\[ H_d: \text{POI}(1) + \text{an unknown person} \]
or
\[ H_p: \text{POI}(1) + \text{POI}(2) \]
\[ H_d: \text{POI}(2) + \text{an unknown person} \]
or
\[ H_p: \text{POI}(1) + \text{POI}(2) \]
\[ H_d: 2 \text{ Unknown people} \]

POI(2) on trial and concede POI(1) present?

POI(1) on trial and concede POI(2) present?

Circumstances indicate both or neither?

Assuming they are both present, this LR will be huge
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Credit Dr Hannah Kelly
Example 6

- Scenario: A complainant walking through a city park is attacked from behind and is sexually assaulted on a blanket.
- Complainant = 10,11
- Person of interest = 12,13
- Profile is fully explained by mixing of C and POI’s DNA
Example 6

- I: a blanket in a park where an alleged rape occurred
- Complainant = 10,11
- Person of interest = 12,13
- Profile is fully explained by mixing of C and POI’s DNA
  
  \[ H_p: \quad C + POI \]
  
  \[ H_d: \quad ? \]
  
  \[ H_{d1}: \quad C + \text{Unknown} \]
  
  \[ H_{d2}: \quad \text{Unknown} + POI \]
  
  \[ H_{d3}: \quad \text{Unknown} + \text{Unknown} \]
Example 6

• Statement
  – $H_p$: The DNA came from Complainant + POI
  – $H_d$: I have considered whether the DNA came from Complainant + Unknown, or POI + Unknown or 2 Unknowns
  – The $LR$ is at least ....
Example 7. Consider a multiple homicide where four people, D1, …, D4, are killed. A blood stain is recovered from the address of the person of interest. This stain appears to arise from four contributors and can be fully explained by D1, …, D4.
Example 8. A woman, C, attends a party at a gang house which is next door to her own house. She states that she was raped by POI in her own bed the following morning. POI states that he had consensual sex with her on his bed and then more consensual sex with her in her bed the next morning. A stain is analyzed from the sheet of POI’s bed. This can be explained as a mixture of C, POI, and female A. Female A is the usual partner of POI.
Example 9. The complainant states that she was raped at her home by POI after a drunken party. POI matches the DNA from the complainant’s cervical swab. No statement is available from the defense at the time of analysis. The reporting officer proceeds with the propositions:

Hp sub-source: The DNA came from POI (or C and POI if it is a mixture)

Hd sub-source: The DNA came from U (or C and U if it is a mixture)

The reporting officer assigns and reports an LRsub-source=10^9.

At trial, the defense said that POI had previously masturbated and cleaned up with the last of the toilet paper on the roll and threw it in trash can next to toilet. Defense suggest that C used the toilet, realized there was no toilet paper on the roll, so she must have reached into the trash and used that toilet paper.
$H_p$ and $H_d$

What about brothers or cousins?

This is not a problem specific to LRs, however, LRs can accommodate this.
What if my defence is that the DNA got there by some other means?

Then $H_p$ and $H_d$ both say the DNA came from Mr Smith. The discussion moves to transfer and contamination.
Reporting the likelihood ratio

• How do we communicate this number?
• “The evidence is a billion times more likely if the person of interest is the donor of the stain than if a random, unrelated person is the donor of the stain”

\[
\frac{\Pr(E \mid H_p)}{\Pr(E \mid H_d)}
\]
Summary

Truth

Candor

Comprehension
Avoiding Logical Fallacies

- Prosecutors fallacy
- Defence fallacy
- Uniqueness fallacy
Prosecutor’s Fallacy
The fallacy is to transpose the conditional:

$$\Pr(E|H_d, I) = \Pr(H_d|E, I)$$
there is a very high probability that an animal has four legs if it is an elephant.

\[ \Pr(\text{Four legs} \mid \text{Elephant}) = 0.9999 \]
SO!! - there is a very high probability that an animal is an elephant if it has four legs.

\[
\Pr(\text{Four legs} \mid \text{Elephant}) = 0.9999
\]

\[
\Pr(\text{Elephant} \mid \text{Four legs}) = 0.9999
\]
Examples about elephant’s legs may seem easy to follow - but it’s often not so easy in court proceedings.
Stella’s spotting trick

\[ \Pr(\text{Evidence} \mid \text{Proposition}) = \text{Correct} \]

\[ \Pr(\text{Proposition} \mid \text{Evidence}) = \text{Incorrect} \]

\[ \Pr(\text{Proposition}) = \text{Incorrect} \]
The probability that the DNA came from someone else is very low.

**Proposition**

\[ H_2: \text{The DNA came from someone else} \]

\[ \Pr[E|H_2] \text{?} \quad \Pr[H_2|E] \text{ or } \Pr(H_2) ? \]
The probability of this DNA profile if it came from someone else is very low.

**Proposition?**

- $H_2$: The DNA came from someone else

- $E$: This DNA profile

- $\Pr [E|H_2]$?

- $\Pr [H_2|E]$ or $\Pr(H_2)$?
Prosecutor’s Fallacy

\[ \Pr(E|H_d, I) = 1 \text{ in 7 million} \]

In layman’s terms, just so I get this right, are you saying that the probability that the DNA that was found in the question samples came from anyone else besides A.L. is one in 7 million (…)?

State v. Lee, No. 90CA004741 (Ohio App. Dec. 5, 1990), transcript at 464
Prosecutor’s Fallacy

Pr(E | H_d, I) = 1 in 10 million

The witness concludes that the genetic profile of the two analyzed samples match perfectly, and he deduces that the probability of someone other than the suspect being the source of the trace found on the victim’s clothes is 1 in 10 million.

modified from:
State of Arizona v. Michael Steven Gallegos [178 Ariz. 1; 870 P.2d 1097 (1994)]
As forensic scientists we have been taught to be very careful about the wording of probability statements...

Subtle misstatements have led to misunderstanding in the past...

...I’m unsure about the exact wording of your sentence. I am trained to give you some that are known to be correct.
A statement about the probability that Mr Smith left the stain can only be made from all the evidence, not from the DNA alone.

The DNA evidence by itself increases the odds that Mr Smith is the donor LR times over what they would be from the other evidence.

This represents extremely strong support that he is the donor.
Evidence of this strength would occur less than 1 in LR of the time from a random donor.
Defense Attorney’s Fallacy

\[ \Pr(E | H_d, I) = 1 \text{ in } 1,000 \]

The city where the crime occurred has a population of 200,000. In this city, this genotype would be found in 200 people. Therefore the evidence merely shows that the person of interest is one of 200 people in the city who might have left the crime stain.

Defense Attorney’s Fallacy

The fallacy is:

1. 200 individuals in the population plus the genotyped POI is equal to 201
2. To assume that each of these 200 individuals has the same prior probability of being the source of the crime stain as the POI
3. To assume that the actual number of individuals in this city having the genotype in question is equal to the expected number of individuals having this genotype. The actual number could be anywhere between 1 and 200,000.
Pr(E|\(H_d, I\)) = 1 in 1,000

The city where the crime occurred has a population of 200,000. In this city, we would expect to find this genotype in 200 untyped people in addition to the POI.
Uniqueness Fallacy

\[ \Pr(E|H_d, I) = 1 \text{ in } 200,000 \]

The city where the crime occurred has a population of 200,000. In this city, this genotype can therefore only come from the person of interest.
Uniqueness Fallacy

The fallacy is:

1. 1 individual in the population plus the genotyped POI is equal to a total of two individuals

2. To assume that the actual number of individuals in this city having the genotype in question is equal to the expected number of individuals having this genotype. The actual number could be anywhere between 1 and 200,000.
The city where the crime occurred has a population of 200,000. In this city, we would expect to find this genotype in 1 untyped person in addition to the POI.
Verbal scales
Should I report a verbal equivalent?

• Verbal impression of the weight of evidence
• This association of words with numbers is subjective and necessarily arbitrary
Verbal scales to express LR s

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**Association of words with numbers is subjective**
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</tbody>
</table>
2 person mixtures

The purists would strongly disagree but…
3 person mixtures
4 person mixtures
4 person mixtures

Unreliable?
Inconclusive?
No - uninformative
<table>
<thead>
<tr>
<th>pro</th>
<th>con</th>
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</thead>
<tbody>
<tr>
<td>Gives the correct “feel”</td>
<td>Chr -Y</td>
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<tr>
<td>Lowers CSI effect</td>
<td>Other evidence types</td>
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<td>Distain from purists</td>
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</tbody>
</table>
Should I report a verbal equivalent?

• Yes. The verbal scale is helpful for the jury to put the $LR$ into perspective (particularly low level evidence)

• No. The verbal scale is not the responsibility of the forensic science (and can be a plaything of lawyers)