

The logical structure of expert evidence in court

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The court is to be a finder of fact – in the light of the available evidence to decide if the probability that an event took place is above a certain limit (“beyond reasonable doubt”) – $p(H|E) > k$. The court will seldom explicitly use conditional probabilities, but this is still the underlying logical structure. The court often calls for expert evaluation of the evidence. The expert cannot ascertain the probability of the hypothesis given the evidence, but rather the probability of observing the evidence given the hypothesis, $p(E|H)$. Failure to acknowledge this (“transposing the conditionals”) might lead to *the prosecutor’s fallacy*. In clinical epidemiology, this would be confusion between the *positive predictive value* and *sensitivity* of a test.

In odds notation:

$$p(H_p|E)/p(H_d|E) = p(H_p)/p(H_d) \times p(E|H_p)/p(E|H_d)$$

(Posterior odds = prior odds \times likelihood ratio (LR))

H_p and H_d are two mutually exclusive propositions, often denoted as the propositions of the prosecutor and of the defendant. The role of the expert is to evaluate the evidence conditioned on these two hypotheses. The LR is the ratio of the probabilities to observe the evidence given the two competing propositions. It is logically impossible to assess the strength of evidence without considering an alternative hypothesis, and the choice of the alternative proposition in a given case will influence the LR (the strength of evidence). The prior odds is the court’s belief before the evidence is presented, and falls outside the expert’s domain. The posterior odds is the belief updated by the evidence.

The LR should be scientifically based, but the structure does not necessarily require numerical data, and may be expressed verbally.

This way of presenting evidence has long been acknowledged in forensic genetics (and clinical epidemiology) but is just as true in forensic pathology and clinical forensic medicine and should guide how we report our evaluations. This would both clearly delineate the expert’s role from the court’s as well as give a framework for assessing the strength of evidence in a more quantitative and transparent way.