Simplified calculations using likelihood ratios

Likelihood ratios (LRs) have emerged as one of the most useful means to describe the implications of diagnostic test results. Unfortunately, many clinicians have difficulty relating LRs to the more familiar concepts of pretest and posttest probability, perhaps because the mathematics of LRs do not conveniently mesh with probabilities (1). In the Table, I present an integer-only algorithm useful in quickly appreciating the clinical implications of an LR. The method is simple enough to be applied mentally, without recourse to calculators or other mechanical aids.

The algorithm computes the posttest probability (P) of disease as P = MI/(MI + NJ). This is conveniently remembered as the “heart attack in New Jersey” equation. The Table defines the terms of the equation. M and N derive from the pretest probability, while I and J derive from the LR. “M” is conveniently remembered as the “multiplier” that yields the pretest probability.

Heart attack in New Jersey formula*

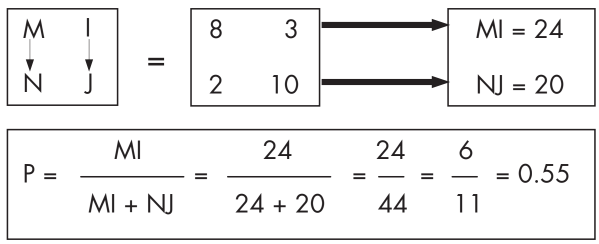
Variable	Definition	Example value†
M	First digit past the decimal point in the pretest probability (i.e., the multiplier of 0.1 that yields the pretest probability)	8
N	10 – M	2
I	LR numerator	3
J	LR denominator	10
P	Posttest probability	24/44

*Heart attack in New Jersey formula: *P* = MI/(MI + NJ).
†The example values pertain to a pretest probability of 0.8 and a likelihood ratio of 0.3.

Consider a patient with a pretest probability of 0.8 who has a negative result on a diagnostic test, such that the LR is 0.3. The Table shows that in this example M = 8, N = 2, I = 3, and J = 10 and that the posttest probability of disease is MI/(MI + NJ) = 24/(24 + 20) = 24/44 = 0.55. Note that when the LR is an integer, J = 1.

At most, 6 numbers must be juggled in one’s short-term memory to use the algorithm. Many, but not all, clinicians will be capable of this. Using the numbers from the Table, the Figure shows a mental trick that may help clinicians successfully juggle the numbers. I have found that mentally arranging and visualizing the numbers as laid out in the top row of boxes in the Figure facilitates calculation without pen and paper.

Straightforward algebra confirms that the algorithm provides exact results for the posttest probability whenever the pretest probability is an integral multiple of 0.1. In other situations, the change in probability from pretest to posttest may be reasonably estimated by rounding the pretest probability to the nearest tenth, computing the posttest probability using the method described, and then computing the change in probability. With this approximation, significant errors arise only when the pretest probability (P_0) and the LR are at opposite extremes (e.g., when $P_0 > 0.9$ and LR < 0.3, or when $P_0 < 0.1$ and LR > 30). If P_0 has no more than 2 digits past the decimal point, persons with greater capabilities for mental mathematics can completely eliminate error by defining M as the 2 digits of P_0 and N as 100 – M.



Mental layout to calculate posttest probability using the “heart attack in New Jersey” formula.

Mathematical proofs and error graphs are available at www.sotos.com.

Although slide rules, nomograms, calculating software, and other supposedly simplifying algorithms exist for using LRs (1), I hope the mnemonic simplicity of this algorithm, with no need to find and operate a pocket calculating device, will increase adoption of a valuable quantitative tool in medicine.

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Reference

1. **Grimes DA, Schulz KF.** Refining clinical diagnosis with likelihood ratios. Lancet. 2005;365:1500-5.