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The Savvy Practitioner

A bulletin for practitioners and teachers of informed-based practice.

Target audience this issue:

- ✓ *Faculty in general*

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Likelihood Ratios

In the last issue of the *Savvy Practitioner,* we reported on a clinical prediction rule for diagnosing COVID-19 which showed some promise (Smith 2020). The combination of loss of taste or smell, fever and cough, but no wheeze or chest tightness produced a +LR 15 which is considered quite good for diagnosis. Let's take a closer look at likelihood ratios (LR) and what they tell a provider.

LR's are used to express the effectiveness of a diagnostic test to help rule in or rule out a condition. More specifically, they express a change in odds that a patient has the condition or not. They are a combination of a test's sensitivity and specificity. The positive likelihood ratio (+LR) represents the increase in odds of having a diagnosis in patients usually when a test is positive. The increase is expressed in the form of a ratio. For example, a +LR of 10 would indicate a 10-fold increase in the odds of having a particular condition. The larger the +LR, the more informative the test. A negative likelihood ratio (-LR) represents a decrease in the odds of having the condition in patients with a negative test. The number reports a reduction in the odds, so the numbers are usually <1.0. For example, a -LR of 0.1 would indicate a 10-fold decrease in the odds of having a condition. An even smaller –LR of 0.05 would be a 20-fold decrease in the odds. The smaller the -LR, the more informative the test.

But odds are very not intuitive concepts. For example, a 10 fold increase in odds that a patient has a disc herniation doesn't really answer the question: "But, doc, what are the chances [i.e., *probability*] that I have a disc herniation?" A +LR of 10 does *NOT* denote a 10-fold increase in probability! The increase in probability is usually a great deal less than that. In many cases, it would represent about a 45% increase in probability, not a 900% increase. So LRs can give us a better sense of what a test result actually is telling us. They can be used to project the change in the probability of having a particular condition from what we first thought (i.e., the pre-test probability) to the probability *after the test results are interpreted* (i.e., the posttest probability). But to do this, a "conversion" step must be taken. Here are three simple ways to calculate/estimate posttest probability using LRs: 1) Limit yourself to a *qualitative* sense of the change in probability; 2) make a rough estimate of the posttest probability in your head; 3) use a LR calculator.

Get a qualitative sense

A test with a relatively high LR (e.g., $\geq$ **10)** will result in a large and significant increase in the probability of a condition. A LR of **5** will moderately increase the probability of a condition, given a positive test. And a LR of **2** only increases the probability a *small amount.* A relatively low likelihood ratio (0.1) will significantly decrease the probability of a disease, given a negative test. **A LR of 1.0 means that the test is not capable of changing the post-test probability either up or down and so a test with such a poor rating is not worth doing to begin with and should be abandoned.**

Help your students understand how to read a paper assessing a diagnostic procedure.

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Make a rough estimate in your head

You can learn a few "LR to probability" conversions that can be used as reference points. These references points can then be used to make a rough posttest probability estimate. They are as follows: +LR = **2** increases the probability of the particular condition you are testing for by ~**15 percent;** +LR = **5** increases the probability of the disease by ~**30 percent**; +LR = **10** increases the probability of the disease by ~**45 percent**. The negative LRs conversions are as follows: 1)-LR = 0**.5** decreases the probability of the condition by ~**15 percent**; 2) -LR = 0.**2** decreases the probability by ~**30 percent**; 3) -LR = 0.**1** decreases the probability by ~**45 percent.** Of course, these are only rough estimates. They work best when the pre-test probability hovers around 50%. They are not very accurate when there is at a very low probability (approaching 10% or less) or very high probability (approaching 90% or more).

Use a likelihood ratio calculator

There are a number of online sites that have calculators which allow you to simply plug in your estimated prevalence (which, in this case, is essentially the same thing as pre-test probability) and a known likelihood ratio. The resulting increase or decrease in post-test probability will be calculated for you. An easy one to use is Diagnostic Test Calculator at EBM and Decision Tools by Alan Schwartz.

Bottom line

An LR *links* a particular test to a particular diagnosis. For example, to express that a resting tremor has a +LR of 23 *doesn't mean anything*! Does it increase the odds of a nervous system disease in general? Or specifically thyroid disease? Or Parkinson's disease?

A few additional warnings are in order when considering LRs from the research literature. LRs for the same test can vary from study to study and are only as valid as the quality of research which reports them. LRs reported in high quality systematic reviews, in general, may be more trustworthy than LRs generated by a single study. Tests that appear at first to be very accurate, very often do not hold up under further scrutiny. Most LRs in musculoskeletal care reflect how effective tests are in a surgical or specialty clinic environment (e.g., patients referred to an orthopedist or neurologist). Portal of entry providers, however, see a broader mix of patients. These include mild or moderate presentations where the tests may not be as robust as in the original study setting.

QUICK REFERENCE TABLE

Estimated % change in probability	+LR Odds ↑ RULE IN	SHIFT IN POST-TEST PROBABILITY	−LR Odds ↓ RULE OUT	Estimated % change in probability
10 ≈ 45% ↑	10	← LARGE →	< 0.1	0.1 ≈ 45% ↓
5 ≈ 30% ↑	5-10	← MODERATE →	.1-.2	0.2 ≈ 30% ↓
2 ≈ 15% ↑	2-5	← SMALL → (but sometimes important)	.2-.5	0.5 ≈ 15% ↓

Note: Very useful LRs are > 10 and < .10. But these estimates apply best when pre-test probability is 50%; estimates are significantly smaller (and less accurate) at higher & lower pre-test probabilities.

References

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