

EDUCATIONAL

Evidence Based Emergency Medicine

Part 3: Positive and Negative Likelihood Ratios of Diagnostic Tests

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Received: July 2015; Accepted: August 2015

Introduction:

In the previous two parts of educational manuscript series in Emergency, we explained some screening characteristics of diagnostic tests including accuracy, sensitivity, specificity, and positive and negative predictive values (1, 2). In the 3rd part we aimed to explain positive and negative likelihood ratio (LR) as one of the most reliable performance measures of a diagnostic test (3). To better understand this characteristic of a test, it is first necessary to fully understand the concept of sensitivity and specificity. So we strongly advise you to review the 1st part of this series again (1, 2). In short, the likelihood ratios are about the percentage of people with and without a disease but having the same test result (4). The prevalence of a disease can directly influence screening characteristics of a diagnostic test, especially its sensitivity and specificity. Trying to eliminate this effect, LR was developed. Pre-test probability of a disease multiplied by positive or negative LR can estimate post-test probability. Therefore, LR is the most important characteristic of a test to rule out or rule in a diagnosis. A positive likelihood ratio > 1 means higher probability of the disease to be present in a patient with a positive test. The further from 1, either higher or lower, the stronger the evidence to rule in or rule out the disease, respectively (5). It is obvious that tests with LR close to one are less practical. On the other hand, LR further from one will have more value for application in medicine. Usually tests with $0.1 < LR < 10$ are considered suitable for implication in routine practice.

Calculation:

Positive likelihood ratio (LR+):

It is the ratio of probability of a patient with a disease and having positive test result divided by probability of a patient without a disease but having positive test result (7). It can be directly calculated from this equation:

$$LR+ = \frac{\text{sensitivity}}{1 - \text{specificity}}$$

Example 1: Imagine that there is a diagnostic test, which has sensitivity and specificity of 80% and 60%, respectively. In this scenario, the positive likelihood ratio of this test will be calculated as follows:

$$LR+ = 0.80 / (1 - 0.60) = 0.80 / 0.40 = 2$$

Negative likelihood ratio (LR -):

It is the ratio of probability of a patient with a disease and having positive test result divided by probability of a patient without a disease but having positive test result (5). It can be directly calculated from this equation:

$$LR- = \frac{1 - \text{sensitivity}}{\text{specificity}}$$

Example 2: Imagine that we have a diagnostic test with sensitivity and specificity of 90% and 70%, respectively. In this case, the negative likelihood ratio is calculated as follows:

$$LR- = (1 - 0.9) / 0.7 = 0.1 / 0.7 = 0.14$$

Example 3: In the study by Aminiahdashti et al., the sensitivity and the specificity of the ascites fluid appearance as a diagnostic test for the detection of spontaneous bacterial peritonitis were 46.9% and 87.5%, respectively (6). So, positive and negative likelihood ratios of this test can be calculated as follows:

$$LR+ = 46.9\% / (1 - 87.5\%) = 0.469 / (1 - 0.875) = 0.469 / 0.125 = 3.8$$

$$LR- = (1 - 0.469) / 0.875 = 0.531 / 0.875 = 0.6$$

Example 4: In Taghizadieh et al. study, chest X-Ray in diagnosis of pleural effusion had sensitivity and specificity of 66.7% and 77.8%, respectively (7). Given this data, the LR + and LR - can be calculated as follows:

$$LR+ = 0.667 / (1 - 0.778) = 0.667 / 0.222 = 3$$

$$LR- = (1 - 0.667) / 0.778 = 0.333 / 0.778 = 0.4$$



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