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Evidence Based Emergency Medicine
Part 2: Positive and negative predictive values of diagnostic tests

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Introduction:

In volume 3, number 2, pages 48-49, we explained some screening characteristics of a diagnostic test in an educational manuscript entitled "Simple definition and calculation of accuracy, sensitivity and specificity" (1). The present article was aimed to review other screening performance characteristics including positive and negative predictive values (PPV and NPV). PPV and NPV are true positive and true negative results of a diagnostic test, respectively (2). In other words, if a subject receives a certain diagnosis by a test, predictive values describe how likely it is for the diagnosis to be correct

Definitions:

Patient: positive for disease

Healthy: negative for disease

True positive (TP)= the number of cases correctly identified as patient

False positive (FP) = the number of cases incorrectly identified as patient

True negative (TN) = the number of cases correctly identified as healthy

False negative (FN) = the number of cases incorrectly identified as healthy

Positive predictive value:

Positive predictive value is the proportion of cases giving positive test results who are already patients (3). It is the ratio of patients truly diagnosed as positive to all those who had positive test results (including healthy subjects who were incorrectly diagnosed as patient). This characteristic can predict how likely it is for someone to truly be patient, in case of a positive test result.

$$\textbf{Positive predictive value} = \frac{TP}{TP + FP}$$

Negative predictive value:

Negative predictive value is the proportion of the cases giving negative test results who are already healthy (3). It is the ratio of subjects truly diagnosed as negative to all those who had negative test results (including patients who were incorrectly diagnosed as healthy). This characteristic can predict how likely it is for someone to truly be healthy, in case of a negative test result.

$$\textbf{Negative predictive value} = \frac{TN}{TN + FN}$$

Predictive values and the prevalence of the disease:

Since the ratio includes both healthy and patient subjects, predictive values are affected by the prevalence of the disease and can differ from one setting to another for the same diagnostic test. The lower the prevalence of the disease, the higher its negative predictive value. On the other hand, the higher the prevalence of the disease, the higher the positive predictive value. For solving these problems, positive and negative likelihood ratios were developed, which will be introduced and discussed in part three of EBM series articles of Emergency.

Examples:

Example 1: Imagine we have a sample population of 100 people, 50 healthy and the others patients. If the test was positive for 75 people of this population, the PPV and NPV of test are as follows:

PPV: 50/75 = 0.66 or 66.6%. This means that in this population, 66.6% of people whose test result is positive, have the disease.

NPV: 25/25 = 100%. This means that in this population, 100% of the people whose test result is negative, are healthy (Figure 1).

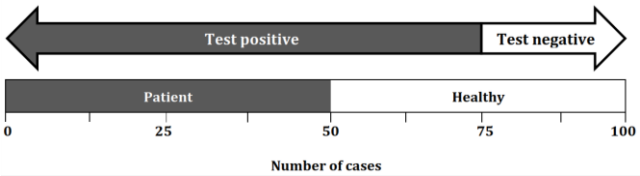

Figure 1: A schematic presentation of an example test with 66.6% PPV, and 100% NPV.

Example 2: In a study by Aminiahidashti et al. (4), out of a total population of 80 cirrhotic patients, 21 (26%) had opaque ascites fluid appearance (Figure 2). 15 people out of the 21 had spontaneous bacterial peritonitis (SBP).

Question: Please calculate sensitivity, specificity, accuracy, PPV, and NPV of opaque ascites fluid in prediction of SBP if the total number of SBP patients was 40 cases (50%).

Answer: Considering the total number of 40 patients and 15 TP cases, there were 25 cases of FN. In addition, total number of negative test was equal to 59. Therefore, number of TN cases: 59 – 25 = 34.

Based on the above-mentioned calculations, screening performance characteristics of ascites fluid appearance in prediction of SBP are as follows:

Sensitivity: 15/40 = 37.5%

Specificity: 34/40 = 85%

Accuracy: (15 + 34) / 80 = 61.2%

PPV: 15/21= 71.4%

NPV: 34/59 = 57.6%

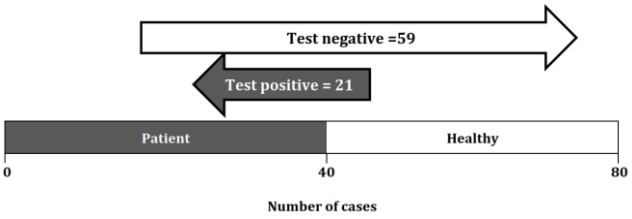

Figure 2: A schematic presentation of the example 2.

	SBP		Total
	Positive	Negative	
Ascites fluid appearance			
Positive	TP = 15	FP = 6	21
Negative	FN = 25	TN = 34	59
Total	40	40	80

Example 3: In the Haghighi et al. study (5), out of the 130 patients, 13 already had traumatic lens dislocation and 117 were healthy. However, ultrasonography was positive for lens dislocation in 13 cases, while 2 cases were FP (Figure 3).

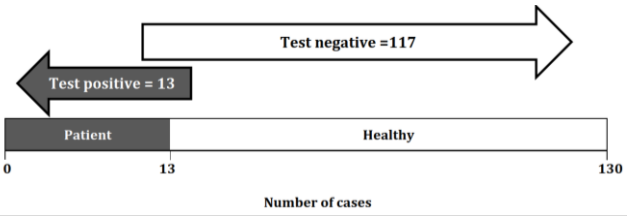

Figure 3: A schematic presentation of the example 3.

	Lens dislocation		Total
	Positive	Negative	
Ultrasonography			
Positive	TP = 11	FP = 2	13
Negative	FN = 2	TN = 115	117
Total	13	117	130

Question: Please calculate sensitivity, specificity, accuracy, PPV, and NPV of ultrasonography in detection of traumatic lens dislocation.

Answer: Considering the total number of 13 patients and 2 FP cases, there were 11 TP cases.

Screening performance characteristics of ultrasonography in prediction of traumatic lens dislocation are as follows:

Sensitivity: 11/13 = 84.6%

Specificity: 115/117 = 98.3%

Accuracy: (11 + 115) / 130 = 96.9%

PPV: 11/13 = 84.6%

NPV: 115/117 = 98.3%

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