Deacon's Challenge

No 183 - Answer

A medical team is considering a change of screening strategy for a disease X. The traditional test A has a sensitivity of 95% and specificity of 60% for disease X. A new test B has been introduced which has an increased specificity 75% for this disease but a reduced sensitivity of 75%. Calculate the positive and negative predictive values for each test for a population in which X has a true prevalence of 10%.

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The positive predictive value of a test (PV+) is the proportion of positive results which are true positives whereas the negative predictive value (PV-) is the proportion of negative results which are true negatives:

$$PV(+) = \frac{TP}{TP + FP} \qquad PV(-) = \frac{TN}{TN + FN}$$

The problem can be solved by calculating the individual values for TP, FP, TN and FN and substituting them into the above expressions. However, there is a quicker alternative.

TP is the proportion of positive results obtained for the diseased population which can be obtained by multiplying the sensitivity by the proportion of diseased individuals:

$$TP = \text{Sensitivity} \times \text{Prevalence}$$

FP is the proportion of positive results for individuals without disease which can be obtained by multiplying the proportion of disease-free individuals (1 - prevalence) by (1 - specificity) – since specificity is the proportion of negative results in the disease-free population (1 - specificity) must be the proportion of positive results in this group:

$$FP = (1 - \text{specificity}) \times (1 - \text{prevalence})$$

TN is the proportion of negative results for individuals who are disease free and is simply the product of specificity and (1 - prevalence):

$$TN = \text{Specificity} \times (1 - \text{prevalence})$$

FN is the proportion of negative results for individuals with the disease and is obtained by multiplying the proportion of diseased individuals (prevalence) by (1 - sensitivity) – since sensitivity is the proportion of positive results in the diseased population (1 - sensitivity) must be the proportion of negative results in this group:

$$FN = (1 - \text{sensitivity}) \times \text{Prevalence}$$

Substitution of these values into the expressions for positive predictive values yields the following:

$$PV(+) = \frac{\text{Sensitivity} \times \text{Prevalence}}{(\text{Sensitivity} \times \text{Prevalence}) + \{(1 - \text{specificity}) \times (1 - \text{prevalence})\}}$$

$$PV(-) = \frac{\text{Specificity} \times (1 - \text{prevalence})}{\{(\text{Specificity} \times (1 - \text{prevalence})\} + \{(1 - \text{sensitivity}) \times \text{Prevalence}\}}$$

Note that sensitivity, specificity and prevalence are given as proportions rather than percentages.

Therefore for test A the sensitivity is 0.95 and specificity 0.6. For test B both the sensitivity and specificity are 0.75. The prevalence of disease (given as 10%) becomes 0.1.

For test A:

$$PV(+) = \frac{0.95 \times 0.1}{(0.95 \times 0.1) + \{(1 - 0.6) \times (1 - 0.1)\}} = \frac{0.095}{0.095 + 0.36} = \mathbf{0.21}$$

$$PV(-) = \frac{0.6 \times (1 - 0.1)}{\{0.6 \times (1 - 0.1)\} + \{(1 - 0.95) \times 0.1\}} = \frac{0.54}{0.54 + 0.005} = \mathbf{0.99}$$

For test B:

$$PV(+) = \frac{0.75 \times 0.1}{(0.75 \times 0.1) + \{(1 - 0.75) \times (1 - 0.1)\}} = \frac{0.075}{0.075 + 0.225} = \mathbf{0.25}$$

$$PV(-) = \frac{0.75 \times (1 - 0.1)}{\{0.75 \times (1 - 0.1)\} + \{(1 - 0.75) \times 0.1\}} = \frac{0.675}{0.675 + 0.025} = \mathbf{0.96}$$

Question 184

A new assay is being devised for the measurement of phenytoin. In an assessment of recovery, aliquots of a solution of phenytoin sodium (1 mg in 1 mL) are added to separate 1 mL aliquots of a serum sample and the aliquots mixed then re-assayed with the following results:

Aliquot	Added aliquot of phenytoin standard (µL)	Apparent phenytoin concentration measured by new assay (µmol/L)
A	0	40
B	10	80
C	20	125
D	30	176

Calculate the recovery for aliquots A, B, C and D and give an explanation for the pattern observed (Mol. W. of phenytoin sodium 274)

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