Deacon's Challenge No. 28 Answer

A proposed diagnostic serological test for coeliac disease was evaluated in 200 consecutive patients referred to a paediatric gastroenterology service in whom the condition was suspected clinically. The test result was compared with the diagnosis as established by biopsy, withdrawal of gluten and response to re-challenge. On this basis, 76 children had the condition of whom only 64 gave a positive test result: 10 positive test results occurred in children who were shown not to have coeliac disease.

Calculate the sensitivity and specificity of the test and the predictive value of a positive result.

MRCPath, May 1998

Number of true positives, i.e. positive results in patients with disease = TP = 64
Number of true negatives, i.e. negative results in patients without disease = TN = ?
Number of false positives, i.e. positive results in patients without disease = FP = 10
Number of false negatives, i.e. negative results in patients with disease = FN = ?

In order to proceed, first determine the missing values for TN and FN as follows:

Total number in population tested, $(TP + FP + TN + FN) = n = 200$

Number of patients with disease, $(TP + FN) = 76$

Substitute TP = 64 and solve for FN:

$64 + FN = 76$, therefore $FN = 76 - 64 = 12$

Number of patients without disease $(TN + FP) = n - (TP + FN)$

Substitute FP = 10, $(TP + FN) = 76$ and n = 200, then solve for TN:

$TN + 10 = 200 - 76$ therefore $TN = 200 - 76 - 10 = 114$

The sensitivity of a test is its positivity, i.e. the proportion of true positives obtained for patients with disease:

$$\text{Sensitivity (\%)} = \frac{TP \times 100}{TP + FN} = \frac{64 \times 100}{76} = 84\%$$

The specificity of a test is its negativity, i.e. the proportion of true negatives in patients without disease:

$$\text{Specificity (\%)} = \frac{TN \times 100}{TN + FP} = \frac{114 \times 100}{114 + 10} = 92\%$$

Note that the terms sensitivity and specificity relate to single populations with and without disease respectively and are therefore unaffected by prevalence of disease.

The predictive value of a test describes the reliability of a positive or negative result in the population being tested, which will contain patients both with, and without, disease, and so will be affected by prevalence of disease.

The predictive value of a positive result, PV(+), is the proportion of all positive results which are true positives (i.e. will include false positives, the number of which will depend on prevalence of disease):

$$PV(+)\,\% = \frac{TP \times 100}{TP + FP} = \frac{64 \times 100}{64 + 10} = 86\%$$

This means that for every 100 positive results, 14 will be from patients without disease.

Although not asked for in this question, the predictive value of a negative result can be similarly calculated:

$$PV(-) = \frac{TN \times 100}{TN + FN} = \frac{114 \times 100}{114 + 12} = 90\%$$

This means that for every 100 negative results, 10 will be from patients with disease. ■

Question No. 29

A male patient (weight 75 Kg) was in a high dependency unit after cardiac surgery. He developed a cardiac arrest just after he had received a bolus injection of an antibiotic through a central line. A junior nurse thought that he had flushed the injection port with Potassium Chloride Concentrate (15%) instead of heparinised saline as he had intended.

The following results were available:

	Serum potassium concentration
Immediately before injection	5.0 mmol/L
Five minutes after injection	6.0 mmol/L

Assuming that:
1) the serum potassium concentration reached a peak one minute after injection and was distributed in the intra-vascular space only
2) by five minutes the potassium was distributed in the extra-cellular space only
3) there was no intra-cellular uptake of potassium:

Estimate
a) The volume of potassium chloride concentrate that was injected
b) The peak serum potassium concentration
c) Comment on the cause of the cardiac arrest.

(Atomic weights: Potassium 39; chloride 35.5)

MRCPath, May 2003