Deacon's Challenge No. 69 Answer

A disease has a prevalence of 10 per cent in the population being tested. A diagnostic test was applied to a random sample of 200 individuals from this population and yielded 15 true positive and 15 false positive results. Calculate a) the pre-test odds of disease being present in a an individual being tested, b) the likelihood ratio positive of the test, and c) the post-test odds of disease for a patient with a positive result.

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a) The prevalence of disease is 10 per cent, which expressed as a proportion is 0.1. In the absence of any other information the pre-test odds can be calculated from the prevalence as follows:

$$\text{Pre-test odds} = \frac{\text{prevalence}}{(1 - \text{prevalence})} = \frac{0.1}{(1 - 0.1)} = \frac{0.1}{0.9} = \mathbf{0.11\ (2\ sig\ figs)}$$

Therefore the pre-test odds of disease are 0.11 to 1 (or 1 to 9) for disease or 9 to 1 against disease.

b) The likelihood ratio positive (LR+) is defined as the ratio between the probability of finding a positive test in the presence of disease, and the probability of obtaining a positive result in the absence of disease:

$$LR+ = \frac{\text{probability of a +ve test with disease}}{\text{probability of a +ve test without disease}}$$

The probability of finding a positive result in the presence of disease is simply the sensitivity of the test. The probability of finding a negative result in the absence of disease is the specificity of the test, so that the probability of a positive test in the absence of disease becomes (1 – specificity). Calculation of LR+ then becomes:

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

If 10% of individuals have the disease then the sum of true positives and false negatives (TP + FN) is simply the total number with disease i.e. 10% of 200 = 20. We know that TP (true positives) = 15 so that the sensitivity of the test can be calculated:

$$\text{Sensitivity} = \frac{TP}{(TP + FN)} = \frac{15}{20} = 0.75$$

90% of individuals must be disease-free and so the total number of true negatives and false positives (TN + FP) is 90% of 200 which is 180. Since we know that there are 15 false positives (FP) then TN can be obtained by subtraction:

$$TN = (TN + FP) - FP = 180 - 15 = 165$$

Which can then be used to calculate specificity:

$$\text{Specificity} = \frac{TN}{(TN + FP)} = \frac{165}{180} = 0.917\ (3\ sig\ figs)$$

LR+ is then calculated from the sensitivity and specificity:

$$LR+ = \frac{0.75}{(1 - 0.917)} = \frac{0.75}{0.083} = \mathbf{9.0}\ (2\ sig\ figs)$$

c) The post-test odds is simply the pre-test odds multiplied by the likelihood ratio positive:

$$\text{Post-test odds} = \text{pre-test odds} \times \text{likelihood ratio positive}$$

$$= 0.11 \times 9.0$$

$$= 0.99\ (2\ sig\ figs)$$

Therefore the positive test result has increased the odds of the patient having the disease from 1:9 to an approximately an even chance (i.e. 1:1).

Question 70

The transmittance of a solution of NADH at 340 nm is 45%.
What is the absorbance at 340 nm of a 1 in 5 dilution of this solution?