Deacon's Challenge

No 145 - Answer

It is proposed to screen men for prostate cancer using single PSA measurement. Your urology colleagues locally wish to calculate the potential impact of the proposed screening programme on clinic numbers. Assume that all patients with values >4 µg/L will be referred to the clinic.

Using the information provided:

(1) How many patients will be referred?
(2) How many of these will have prostate cancer?
(3) What is the diagnostic efficiency of PSA >4 µg/L?
(4) What is the negative predictive value of PSA ≤4 µg/L?

The best local estimates available are an eligible population to be screened of 20,000 men and a prevalence of prostate cancer of 3%.

The diagnostic sensitivity for prostate cancer of a PSA >4 µg/L is quoted to be 67% and the specificity 97%.

FRCPath, Spring 2012

First calculate values for true positives (TP), false positives (FP), true negatives (TN) and false negatives (FN). It is easiest to work with absolute numbers rather than percentages or proportions. Although not essential it helps clarify the mind to set up a table with 3 columns (positive results, negative results and totals) and 3 rows (patients with disease, patients without disease and totals):

	Positive results (PSA >4 µg/L)	Negative results (PSA <4 µ/L)	Total
Men with prostate cancer	TP	FN	TP + FN
Men without prostate cancer	FP	TN	TN + FP
Total	TP + FP	FN + TN	TP + FN + TN + FP

The total number with prostate cancer (TP + FN) is simply the population size multiplied by the prevalence of prostate cancer:

$$TP + FN = \text{Population size} \times \%\ \text{prevalence} = 20{,}000 \times 3/100 = 600$$

This figure, together with the sensitivity can be used to calculate TP:

$$\text{Sensitivity}\ (\%) = \frac{TP \times 100}{TP + FN} \quad \text{which rearranges to} \quad TP = \frac{\text{Sensitivity}\ (\%) \times (TP + FN)}{100}$$

Substitute sensitivity = 67% and (TP + FN) = 600 then solve for TP:

$$TP = \frac{67 \times 600}{100} = 402$$

FN can be obtained simply by subtracting this value from the total with prostate cancer:

$$FN = (TP + FN) - TP = 600 - 402 = 198$$

The total without prostate cancer (TN + FP) is simply the overall number of subjects minus the number with cancer:

$$TN + FP = \text{Overall total} - (TP + FN) = 20{,}000 - 600 = 19{,}400$$

This figure, together with specificity can be used to calculate TN:

$$\text{Specificity}\ (\%) = \frac{TN \times 100}{(TN + FP)} \quad \text{which rearranges to} \quad TN = \frac{\text{Specificity}\ (\%) \times (TN + FP)}{100}$$

Substitute specificity = 97%, (TN + FP) = 19,400 then solve for TN:

$$TN = \frac{97 \times 19{,}400}{100} = 18{,}818$$

FP can be obtained by simply subtracting this value from the total without prostate cancer:

$$FP = (TN + FP) - TN = 19{,}400 - 18{,}818 = 582$$

These values can be entered into the table and the total of each column and row used as a final check:

	Positive results (PSA >4 µg/L)	Negative results (PSA <4 µ/L)	Total
Men with prostate cancer	402	198	600
Men without prostate cancer	582	18,818	19,400
Total	984	19,016	20,000

1. All patients with PSA >4 µg/L will be referred and will consist of both true positives (TP) and false positives (FP).

   Therefore TP + FP = **984 patients will be referred**

2. The number of patients referred who will have prostate cancer is the number of true positives

   = **402 patients**

3. The diagnostic efficiency of PSA >4 µg/L is the positive predictive value PV(+) which is the percentage of all positive results which are true positives:

   $$PV(+) = \frac{TP \times 100}{TP + FP} = \frac{402 \times 100}{984} = \mathbf{41\%}$$ (2 sig figs)

4. The negative predictive value, PV(-), is the percentage of all negative results which are true negatives

   $$PV(-) = \frac{TN \times 100}{TN + FN} = \frac{18{,}818 \times 100}{19{,}016} = \mathbf{99\%}$$ (2 sig figs)

Question 146

An HPLC mobile phase is normally prepared by mixing 27 mL methanol and 20 mL acetonitrile with 153 mL of ammonium acetate buffer. You only have 120 mL of buffer. How much methanol and acetonitrile would you add in order to prepare the maximum amount of mobile phase?