Deacon's Challenge

No 141 - Answer

The symptoms of ovarian cancer are non-specific. The prevalence of ovarian cancer in symptomatic women who present in general practice is 0.23%. If the sensitivity and specificity of CA 125 for detecting ovarian cancer are both 78%, calculate the post-test probability of disease given a positive result.

If the prevalence of ovarian cancer in women who carry the brca1 oncogene is approximately 15%, what would be the post-test probability of disease?

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Post-test probability of disease i.e. positive predictive value, PV(+), is the proportion of all positive results which are actually due to disease

$$PV(+) = \frac{TP}{TP + FP}$$

Requires calculation of true positives (TP) and false positives (FP). It is possible to work with actual numbers (by taking a total population of random size e.g. 10,000), proportions or percentages. Working with percentages:

Sensitivity (%) is the percentage of positives (TP) amongst patients who have the disease (TP + FN)

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

Since (TP + FN) is the prevalence of disease, then $\text{Sensitivity (\%)} = \frac{TP(\%) \times 100}{\text{Prevalence (\%)}}$

which can be rearranged:

$$\mathbf{TP(\%) = \frac{Sensitivity\ (\%) \times Prevalence\ (\%)}{100}}$$

Similarly, specificity (%) is the percentage of true negatives (TN) amongst patients without the disease (TN + FP).

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

Since (TN + FP) is 100 - Prevalence(%), then $\text{Specificity (\%)} = \frac{TN(\%) \times 100}{[100 - \text{Prevalence (\%)}]}$

which can be rearranged: $TN(\%) = \frac{\text{Specificity (\%)} \times [100 - \text{Prevalence (\%)}]}{100}$

Since $FP = (TN + FP) - TN$

substituting the above expression for TN (%) and 100 - prevalence (%) for (TN + FP) gives an expression for FP (%):

$$FP(\%) = 100 - \text{Prevalence (\%)} - \frac{\text{Specificity (\%)} \times [100 - \text{Prevalence (\%)}]}{100}$$

$$FP(\%) = [100 - \text{Prevalence (\%)}] \times [1 - \frac{\text{Specificity (\%)}}{100}]$$

Multiplication throughout by100 and rearrangement gives:

$$\mathbf{FP(\%) = \frac{[100 - Prevalence\ (\%)] \times [100 - Specificity\ (\%)]}{100}}$$

For symptomatic women with prevalence of 0.23%:

$$TP(\%) = \frac{78 \times 0.23}{100} = 0.1794\ \%$$

$$FP(\%) = \frac{(100 - 0.23) \times (100 - 78)}{100} = \frac{99.77 \times 22}{100} = 21.9494\ \%$$

Substitute these values for TP and FP to obtain PV(+):

$$PV(+) = \frac{TP}{TP + FP} = \frac{0.1794}{0.1794 + 21.9494} = \frac{0.1794}{22.1288} = \mathbf{0.0081} \text{ (to 2 sig figs)}$$

Therefore post-test probability of disease is 0.0081 or 0.81% or 1 in 1/0.0081 = 1 in 123

For women with brca 1 oncogene with a prevalence of 15%:

$$TP(\%) = \frac{78 \times 15}{100} = 11.7\%$$

$$FP(\%) = \frac{(100 - 15) \times (100 - 78)}{100} = \frac{85 \times 22}{100} = 18.7\%$$

Substitute these values for TP and FP to obtain PV(+):

$$PV(+) = \frac{TP}{TP + FP} = \frac{11.7}{11.7 + 18.7} = \frac{11.7}{30.4} = \mathbf{0.38} \text{ (to 2 sig figs)}$$

Therefore the post-test probability of disease is 0.38 or 38% or 1 in 1/0.38 = 1 in 2.6

Question 142

A 24 year old man man weighing 70 Kg is admitted following ingestion of ethylene glycol. Calculate the volume of ethanol (10% w/v infusion) required to achieve a plasma ethanol concentration of 11 mmol/L, and the infusion rate required to maintain this once achieved.

Assume the rate of elimination of ethanol follows zero-order kinetics with a rate of 2.2 mmol/L/h.

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