Deacon's Challenge No. 63 Answer

A plasma sample containing 70 g/L protein gives a result of 140 mmol/L for sodium when measured both by flame photometry and a direct-reading ion-selective electrode. By how much would you expect the two results to differ if the sample had had a protein content of only 50 g/L. Indicate any assumptions you made when arriving at your answer.

MRCPath, November 2005

Flame photometry measures sodium as concentration in plasma i.e. 140 mmol/L of **plasma**.

A direct-reading ion-selective electrode measures sodium as activity i.e. 140 mmol/L of **plasma water**. Large molecules such as proteins occupy significant space in solution i.e. displace plasma water. If plasma contains 70 g/L protein then this is equivalent to 0.070 kg/L. Assuming that 1 kg of protein occupies a volume of 1 L then the volume of plasma water in which the sodium is dissolved is 1.0-0.07 = 0.93 L. Assuming that the activity is the same as concentration for sodium in plasma water (i.e. the activity coefficient is one), for a plasma sodium of 140 mmol/L of plasma, the true concentration of sodium in plasma water is:

$$\text{Plasma sodium} = \frac{140}{0.93} = 150.5 \text{ mmol/L water}$$

There are two ways in which the ISE reading can be converted to the same as that obtained by flame photometry (140 mmol/L):

- Subtraction of 10.5 mmol/L from the result
- Multiplication of the result by the factor 140/150.5 i.e. 0.930

At a protein concentration of 50 g/L (occupying 0.050 L plasma), the concentration of sodium in plasma water will be:

$$\frac{140}{(1.00-0.05)} = \frac{140}{0.95} = 147.4 \text{ mmol/L plasma water}$$

Carrying out the two adjustments by the instrument:

- Subtraction of 10.5 gives 147.4 - 10.5 = 136.9 mmol/L
- Multiplication by 0.930 gives 147.4 x 0.930 = 137.1 mmol/L

Therefore the ISE result would be expected to be approximately 3 mmol/L lower than the flame photometer result.

Question 64

An endomysial antibody assay has been reported to have a diagnostic sensitivity of 88% and a diagnostic specificity of 97% for coeliac disease.
What is the probability that a positive result truly indicates coeliac disease in a group of subjects whose pre-test probability of coeliac disease is 1 in 1500?

MRCPath, November 2005