Deacon's Challenge No. 79 Answer

A 75-year old woman has a convulsion after a partial hip replacement. She is found to have a serum sodium concentration of 108 mmol/L. Her estimated weight was 55 Kg. Calculate the volume of 2.7% saline required to increase her sodium concentration to 125 mmol/L (Atomic weights of sodium 23, chlorine 35.5).

MRCPath, May 2006

First calculate the required increase in plasma sodium concentration:

Required Na increase (mmol/L) = target concentration - starting concentration

= 125 - 108 = 17 mmol/L

Sodium is distributed throughout, and largely confined to, the ECF. The next step is to calculate the ECF volume from the body weight using the fact that the human body is approximately 60 per cent water and about one third of this is confined to the ECF:

$$\text{ECF volume (L)} = \text{Body weight (Kg)} \times \frac{60}{100} \times \frac{1}{3}$$

$$= \text{Body weight (Kg)} \times 0.2$$

$$= 55 \times 0.2 = 11 \text{ L}$$

(Strictly speaking the value of 60% refers to males, the water content of females is slightly lower at 55% but since in this case the body weight is only estimated we can ignore the small difference).

Multiplication of this volume by the desired rise in sodium concentration gives the total amount of sodium which must be administered:

$$\text{Amount of Na required (mmol)} = \text{ECF vol (L)} \times \text{Required rise in Na (mmol/L)}$$

$$= 11 \times 17 = 187 \text{ mmol}$$

The next step is to calculate the volume of 2.7% saline which contains this much sodium. First it is necessary to convert the saline concentration from % (i.e. g/100 mL) to mmol/L. Division by its molecular weight gives the concentration in mol/100 mL, multiplication by 10 converts this to mol/L and further multiplication by 1000 converts to mmol/L:

$$\text{Na concentration of 2.7\% saline (mmol/L)} = \frac{2.7 \times 10 \times 1000}{\text{MW of NaCl}}$$

MW NaCl = 23 + 35.5 = 58.5

Therefore

$$\text{Na concentration of 2.7\% saline} = \frac{2.7 \times 10 \times 1000}{58.5} = 462 \text{ mmol/L}$$

The volume of 2.7% saline which needs to be administered is the volume of solution which contains 187 mmol sodium. This volume can be calculated by substituting and rearranging the expression for concentration:

$$\text{Concentration (mmol/L)} = \frac{\text{Amount (mmol)}}{\text{Volume (L)}}$$

$$\text{Volume (L)} = \frac{\text{Amount (mmol)}}{\text{Concentration (mmol/L)}} = \frac{187}{462} = \mathbf{0.40} \text{ L (2 sig figs)}$$

Question 80

75 mg of faeces were homogenised in 1 mL of concentrated hydrochloric acid, 3 mL diethylether added, mixed, 3 mL of water added and mixed again. After centrifugation the aqueous phase (volume 4.5 mL) was scanned in a spectrophotometer using a cell with a 1 cm pathlength and the peak height at 405 nm due to porphyrin, after applying a background correction, was 0.35 absorbance units. A separate 0.250 g portion of faeces was dried in a 100°C oven until its weight was constant (0.125 g). Given that the molar absorption coefficient of porphyrin is 2.75×10^5 L/mol/cm calculate the porphyrin concentration in nmol/g dry weight of faeces.