Deacon's Challenge: No. 2: Answer

During the course of treatment of a patient with diabetic ketoacidosis, 6 litres of physiological saline (0.9%) and 3 litres of dextrose (5%) were infused before the patient's urine output became equal to the rate of infusion. By this time the cumulative urinary output since starting treatment was 2.0 litres of fluid containing 70 mmol sodium. The patient had been catheterized on admission and the residual urine discarded. Estimate the extracellular fluid deficit at the time treatment was begun, indicating any assumptions that you make.

(MRCPath Nov 1999 - modified)

The key to this question is that the bulk of the administered sodium will remain in the ECF and once the patient is fully rehydrated the plasma sodium will return to normal.

First calculate the amount of sodium given:

Total Na^+ given (mmol) = Volume infused (L) x $[Na^+]$ in fluid (mmol/L)
Volume infused = 6 L
Sodium content of fluid = 0.9% = 9g/L. MW of NaCl = 23 + 35.5 = 58.5
$[Na^+]$ in 0.9% saline = $\frac{9 \times 1000}{58.5}$ = 154 mmol/L
Total Na^+ given = 6 x 154 = 923 mmol

Next calculate the amount of sodium retained (Na^+ gain):

Na^+ gain = Na^+ given - Na^+ loss

A total of 70 mmol was lost in the urine:

Na^+ gain = 923 - 70 = 853 mmol

Assuming: the patient is fully hydrated i.e. the ECF volume has returned to normal the plasma glucose has returned to normal i.e. no fluid shift from ICF to ECF there is no significant shift of sodium into cells then the expansion of the ECF due to treatment is equal to the original deficit.

Since we know the concentration of sodium in the expanded portion of the ECF (equal to normal plasma sodium i.e. approx. 140 mmol/L) and the total amount of sodium in this portion (the sodium gain), then it is a simple matter to calculate the volume of ECF which would contain this amount of sodium:

$$\text{ECF expansion (original deficit)} = \frac{\text{Total } Na^+ \text{ gain (mmol)}}{\text{Plasma } [Na^+] \text{ (mmol/L)}} = \frac{853}{140} = 6.1 \text{ litres}$$

Exam tip: These calculations are intended to be simple. If you find yourself involved in complicated, protracted calculations then the chances are you are going wrong. Unless, of course, the examiner has failed to grasp the complexity of the question! ■

Deacon's Challenge No. 3

The imprecision of a certain assay for Troponin I yields a coefficient of variation of 13% between 0.3 and 0.5µg/L, around the decision point for myocardial infarction of 0.4 √g/L. A result of 0.46 √g/L is obtained on a sample. Assuming that is the true level of Troponin I, give an estimate of the probability that analysis of that same sample would give a result below the decision point.

(MRCPath Nov 2000)

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