Deacon's Challenge

No 111 - Answer

A man with Type 2 diabetes was admitted in a hyperosmolar coma with a plasma glucose concentration of 55 mmol/L and a plasma sodium concentration of 130 mmol/L. His body weight at that time was 70 Kg. He was started on an insulin sliding scale and given an infusion of two litres of 0.9% saline over two hours (total sodium input 308 mmol), during which time he produced two litres of urine, with a total sodium excretion of 30 mmol.

After two hours his plasma glucose concentration had fallen to 15 mmol/L. Estimate his plasma sodium concentration at that time.

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First calculate the gain in sodium:

$$\text{Na gained} = \text{Na administered} - \text{Na excreted}$$
$$= 308 - 30$$
$$= 278 \text{ mmol}$$

Assuming that all this sodium remains in the ECF then calculation of ECF (and hence plasma) sodium concentration requires some estimate of ECF volume. Since all of administered fluid was excreted in the urine there has been no change in body water volume since presentation. Furthermore, since the patient presented in a hyperosmolar state, he must have been water depleted, so his ECF volume will be lower than expected from his body weight. However, in the absence of further data we have to make the *approximation* that his body water content is normal (60% of body weight) and that a third of this is ECF:

$$\text{ECF volume} = \frac{(70 \times 60/100)}{3} = 14 \text{ L}$$

$$\text{Gain in ECF (and plasma) Na concentration (mmol/L)} = \frac{\text{Na gained (mmol)}}{\text{ECF volume (L)}}$$
$$= \frac{278}{14}$$
$$= 20 \text{ mmol/L (2 sig figs)}$$

Since sodium always has an associated counter-ion (mainly Cl^-) the gain in osmolality from the saline infusion is *twice* this i.e. 2 x 20 = 40 mmol/L.

The fall in plasma glucose concentration is the difference between the initial and final concentrations:

$$\text{Fall in plasma glucose (mmol/L)} = \text{Initial glucose} - \text{Final glucose}$$
$$= 55 - 15$$
$$= 40 \text{ mmol/L}$$

The decrease in osmolality due to glucose loss will also be 40 mmol/L and exactly balances the increase in osmolality due to the gain of plasma sodium (and its counter-ion). Therefore there will be no stimulus for the osmotic shift of water between the ECF and ICF so that the ECF (and hence plasma) volume is unchanged by the saline infusion. Therefore the expected final plasma sodium concentration is simply the sum of the initial value and the gain in concentration due to the saline infusion:

$$\text{New plasma sodium (mmol/L)} = \text{Initial plasma sodium (mmol/L)} + \text{Gain in plasma sodium (mmol/L)}$$
$$= 130 + 20$$
$$= \mathbf{150\ mmol/L}$$

Question 112

A patient attending a renal outpatient clinic was found to have a plasma creatinine concentration of 135 µmol/L. At a previous clinic visit, three months earlier, his plasma creatinine was only 110 µmol/L. Is this increase in plasma creatinine significant (at the 5% level)? Across this concentration range the between-assay analytical *CV* is 2.8% and the average intra-individual *CV* for plasma creatinine is 7.5%.