Deacon's Challenge No. 15 Answer

1 A patient was mistakenly given 500 mL 20% mannitol ($C_6H_{14}O_6$) intended for the patient in the next bed. Instead of the same volume of normal (0.9%) saline. Calculate the extra osmolal load given over that which would have resulted from isotonic saline.

2 A patient known to have diabetes insipidus is admitted in coma. His plasma osmolality is 324 mosm/kg. If his weight is 85 kg, estimate his body water deficit.

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1 Osmolal load (mOsm) $= \frac{\text{Total given (mg)}}{\text{MW}}$

Since the total amount given (mg) = Concentration of fluid (mg/L) x Volume given (L)

Then, osmolal load (mOsm) $= \frac{\text{Concentration of fluid (mg/L) x Volume given (L)}}{\text{MW}}$

For mannitol:
Concentration of fluid = 20 % = 20 g/100mL = 200 g/L = 200,000 mg/L

Volume given = 500 mL = 0.5 L

MW ($C_6H_{14}O_6$) = (6 x 12) + (14 x 1) + (6 x 16) = 182

Osmolal load $= \frac{200{,}000 \times 0.5}{182}$ = 550 mOsm (2 sig figs)

For saline:
Concentration of saline = 0.9 % = 0.9 g/100mL = 9 g/L = 9000 mg/L

N.B. this concentration must be multiplied by 2 since each molecule of NaCl (unlike mannitol) dissociates to give two osmotically active species (Na^+ + Cl^-).

Therefore, osmotic concentration = 9000 x 2 = 18000 mg/L

Volume given = 500 mL = 0.5 L

MW (NaCl) = 23 + 35.5 = 58.5

Osmolal load $= \frac{18000 \times 0.5}{58.5}$ = 150 mOsm (2 sig figs)

Extra load = Load of mannitol - Load of saline

= 550 - 150 = 400 mOsm

2 Assumptions:
Normal initial osmolality e.g. 284 mOsm/kg
Pure water loss has occurred so that there is no change in the total osmotically active species.
Water loss is shared between all body fluid compartments.

Total initial osmotic species (mosm) = Total final osmotic species (mosm)

Ignoring the small difference between osmolality and osmolarity:

Total osmotic species (mosm) = osmolality (mosm/kg) x Fluid volume (L)

Therefore:

Initial osmolality x Initial vol = Final osmolality x Final vol………….(i)

Initial osmolality = 284 mosm/kg
Final osmolality = 324 mosm/kg

It is unclear whether the body weight was obtained before or after the fluid loss (it is very difficult to weigh an unconcious patient and, if he has been attending as an outpatient for his diabetes insipidus, then a recent body weight is probably available). It actually makes little difference to the final answer and the calculation is more straightforward if 85 kg is assumed to be his initial weight. Assuming the body was initially 60% water, then

Initial vol = Body wt (kg) x 60/100 = 85 x 0.6 = 51 L

Substitute these values into equation (i), rearrange and solve for the final fluid vol.

284 x 51 = 324 x Final vol (L)

Final vol (L) $= \frac{284 \times 51}{324}$ = 45 L (2 sig figs)

Fluid deficit (L) = Initial vol (L) - Final vol (L)

= 51 - 45 = 6 L

N.B. The term osmolality refers to the concentration of osmotically active species per kg of solvent, whereas osmolarity is the concentration expressed per litre of solution. In clinical chemistry we make so many approximations whenever we use osmolality/osmolarity that the small difference is rather academic. ■

Question No. 16

A buffer is required for an enzymatic assay which has a pH of 7.4 and total phosphate concentration of 100 mmol/L. Calculate the amounts of anhydrous sodium dihydrogen phosphate and disodium hydrogen phosphate which need to be weighed in to make 1 L of buffer. The pK of the dissociation is 6.82 (Atomic weights: Na = 23, P = 31).

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