Deacon's Challenge

No 198 - Answer

A 25 year old anorexic female was admitted via A&E with marked emaciation and the following plasma results:

Urea	= *1.5 mmol/L*	*Sodium*	= *120 mmol/L*
Creatinine	= *30 µmol/L*	*Potassium*	= *2.5 mmol/L*

On the ward a repeat blood revealed her plasma osmolality to be 248 mmol/L. A 6 h urine collection yielded the following results:

Volume	=	*0.185 L*
Osmolality	=	*55 mmol/L*

Calculate the free water clearance (in mL/min) and comment on your result.

The first step is to calculate the osmolar clearance (C_{osm}) which is the volume of plasma from which all filterable solutes are removed in any given time period (usually expressed in mL/min). In principle the calculation is identical to any other clearance:

$$C_{osm} = \frac{U_{osm} \times V}{P_{osm}}$$

Where U_{osm} = urine osmolality = 55 mmol/L

P_{osm} = plasma osmolality = 248 mmol/L

V = urine flow rate in mL/min.

Multiply the volume of urine collected by 1,000 to convert from L to mL, divide by 6 to convert from 6 h to 1 h, then finally divide by 60 to convert from 1 h to 1 min:

$$V = \frac{0.185 \times 1{,}000}{6 \times 60} = 0.514 \text{ mL/min (to 3 sig figs)}$$

and $$C_{osm} = \frac{55 \times 0.514}{248} = 0.114 \text{ mL/min (to 3 sig figs)}$$

The calculated difference between the urine flow rate and the osmolar clearance is known as the free water clearance (C_{water}):

$$C_{water} = V - C_{osm} = 0.514 - 0.114 = \mathbf{0.40\ mL/min} \text{ (to 2 sig figs)}$$

The free water clearance is that excreted in addition to that required for excretion of the solute load. Since the value is positive it represents the volume of water extracted from the plasma per minute. In spite of this the patient is still hyponatraemic and is most likely the result of reduced solute available for excretion (particularly urea) due to poor intake (particularly of protein). The diluting capacity of the renal tubules is limited and the lowest attainable urine osmolality is about 50 mmol/L. With a medium protein diet

producing approx. 1200 mmol of solute (mainly urea) the maximum urine volume would be 1200/50 = 24 L per day. In starvation reduced intake (even with increased tissue breakdown) reduces the amount of solute available for excretion. If available solute were to fall as low as 100 mmol/day then the maximum urine output would be 100/50 = 2 L per day. If fluid intake were to exceed this value then the ability to excrete water would be seriously impaired resulting in hyponatraemia.

Question 199

You are setting up an assay for serum adenosine deaminase in which 20 µL of serum is first equilibrated at 37°C with 1.5 mL of buffer in a cuvette with 0.5 cm light path. The reaction is initiated by adding 25 µL of substrate then monitored by measuring the rate of decrease in absorbance at 265 nm. Both substrate and product absorb at this wavelength with the absorbance of inosine being 43% of that due to adenosine.

Derive a factor to convert the rate of absorbance change (per minute) to units of adenosine deaminase activity (expressed as µmol inosine/min/L serum). The molar absorptivity of adenosine is 13,400 $L.cm^{-1}.mol^{-1}$.