Deacon's Challenge

No 181 - Answer

An 8-day old baby was born at 39 weeks gestation weighing 3085 g. He developed an ischaemic encephalopathy and required ventilation. He subsequently became hyponatraemic.

You are provided with his plasma sodium concentrations. The paediatricians decide he requires intravenous sodium supplementation. Estimate his sodium deficit, and the infusion rate of 0.9% saline required to return his plasma sodium concentration to 140 mmol/L over 72 hours.

You should assume that the average healthy term infant has a total body water of approximately 80% body weight, divided equally between intra- and extra-cellular compartments, and a sodium requirement of 4 mmol/kg/day.

Date	16/3/15	22/3/15	23/3/15	23/3/15	24/3/15
Time	15:00	00:00	07:00	21:00	21:00
Sodium	136	139	133	121	115

His sodium intake between 22/3/15 and 24/3/15 was 8.5 mmol/24 hours (6.6 via IVI and 1.9 via milk).

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Make the following assumptions:

- That pure sodium loss has occurred so that the total body water (and body weight) is unchanged.
- That the sodium intake via milk will remain at 1.9 mmol/24h.
- That sodium is confined to the ECF (not entirely true but there are no data on ICF sodium).
- That sodium losses will continue at the same rate.

Calculation of sodium deficit

Total body sodium (mmol) = Plasma sodium (mmol/L) x ECF vol (L)

ECF vol (L) = Body weight (Kg) x Body water (%) x Proportion of ECF

$$= \frac{3085}{1{,}000} \times \frac{80}{100} \times 0.5$$

= 1.23 L

Target body sodium = 140 x 1.23 = 172 mmol

Actual body sodium at day 8 (24/3/15) = 115 x 1.23 = 141 mmol

Sodium deficit = 172 - 141 = **31 mmol**

If this amount of Na is to be replaced over 72h (3 days) the rate of replacement will be 31/72 = 0.43 mmol/h.

Calculation of rate of sodium loss

The plasma Na fell considerably (from 139 to 115 = 24 mmol/L) between 0.00h on 22/3 and 21.00h on 24/3 (over a period of 24 + 21 = 45h). Therefore the rate of fall in plasma Na concentration is 24/45 = 0.53 mmol/L/h. As the ECF volume is 1.23 L the *apparent* rate of total Na loss is 0.53 x 1.23 = 0.65 mmol/h.

However, the actual rate of loss will be higher than this because Na was administered simultaneously.

$$\text{Rate of administered Na (mmol/h)} = \frac{\text{Infusion rate (mmol/d)}}{24}$$

$$= \frac{6.6}{24} = 0.28 \text{ mmol/h}$$

N.B. The contribution from milk can be ignored if it is to be continued to be given at the same rate.

Actual rate of Na loss = Apparent rate of Na loss + rate of IVI Na

= 0.65 + 0.28 = 0.93 mmol/h

Calculation of rate of sodium infusion

Total Na infusion (mmol/h) = Rate required to correct deficit (mmol/h)
+ Rate required to combat continuing losses (mmol/h)

= 0.43 + 0.93 = 1.36 mmol/h

Calculation of rate of saline infusion

Na content in (mmol/mL) of 0.9% saline

$$= \frac{\text{Saline Na (\% =g/100 mL) x 10 (converts g/100 mL to g/L) x 1,000 (converts g/L to mg/L)}}{\text{MW NaCl x 1,000 (converts mmol/L to mmol/mL)}}$$

$$= \frac{0.9 \times 10 \times 1{,}000}{58.5 \times 1{,}000} = 0.154 \text{ mmol/mL}$$

$$\text{Rate of infusion (ml/h)} = \frac{\text{Rate of infusion (mmol/h)}}{\text{Na in saline (mmol/mL)}}$$

$$= \frac{1.36}{0.154} = 8.8 \text{ mL/h (to 2 sig figs)}$$ = **approx. 9 mL/h**

This figure can only be a rough guide, careful monitoring is essential.

Question 182

Your Consultant Endocrinologist has expressed concern that two blood glucose monitors on his ward are yielding discrepant results. As part of your investigation you perform replicate measurements on a QC material on both instruments with the following results:

	Number of results (n)	Mean (m)	Standard deviation (s)
Instrument 1	5	5.6	0.12
Instrument 2	7	6.0	0.14

Does this data support his suspicion?

Two tailed t-distribution:

Degrees of freedom	P			
	0.10	0.05	0.02	0.01
9	1.833	2.262	2.821	3.250
10	1.812	2.228	2.764	3.169
11	1.796	2.201	2.718	3.106
12	1.782	2.179	2.681	3.055
13	1.771	2.160	2.650	3.012