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via Dr Ashgar.

Hyponatraemia in children

Dilutional Hyponatraemia has been documented in otherwise healthy children following routine elective surgery. It occurs in often female children 3-10 years of age and is associated with "stress". Eg postoperatively.

A fluid for children recommended for many years as a standard is 0.18 NaCl in 4% Glucose. It contains 40 mmol/l of sodium which when administered at the calculated rate (4 ml/kg/hour for the first 10 kgs body weight) provides the daily requirement of sodium and glucose.

0.18 NaCl in 4% Glucose is isotonic *in vitro* ie has the same osmotic potential so will not cause fluid shifts within the body. However in the catabolic (sick) child the glucose is metabolised rapidly causing the fluid to become hypotonic thereby leading to massive fluid shifts. At the same time because of the loss of fluid from the circulation often combined with a degree of dehydration a potent anti-diuretic hormone (ADH) response causes the kidneys to retain water resulting in a low volume concentrated urine, high in sodium. This may be compounded by the administration of a "fluid challenge" to elicit an improved urinary output.

This is a "double whammy" excess free water is administered and excess free water is retained. Water is drawn across blood capillaries into the interstitial and intracellular spaces. The child will become "puffy" looking and of greater consequence the brain will swell with the shift of water, leading to seizures and herniation of the tentorium and death. Therefore to prevent hyponatraemia we must limit the free water component of intravenous fluids AND monitor urine output and serum chemistry.

Recommendations;

1. Regular measurement of blood biochemistry, including a baseline measurement and measurements following each intervention, eg, fluid resuscitation or surgery.
2. Maintenance fluids should be calculated separately from "replacement" fluids. The rate of maintenance fluid is critically dependent on Body weight which should be accurately measured or estimated by a professional with substantial paediatric experience.

An accepted guide to maintenance fluid administration is;

For the first 10 kgs body wt give 4 mls / kg / hour (40 mls/hr for a 10 kg infant)

For the second 10 kgs body wt give 40 + 2 mls / kg / hour (60 mls/hr for a 20 kg child)

For each subsequent 1 kg body wt give 60 + 1 ml / kg / hour (70 mls/hr for a 30 kg child)

3. DO NOT give GLUCOSE containing intravenous fluids for fluid resuscitation. This is in keeping with APLS recommendations (use 0.9% NaCl, Normal Saline or other salt solution). You MUST measure blood sugar and administer a GLUCOSE bolus if there is hypoglycaemia (< 3 mmol/L).

4. Maintenance fluid should contain at least 0.45% NaCl in 2.5% Glucose. A balanced

salt solution such as Normal Saline or Hartmann's does not contain glucose. Regular, 12 hourly, blood sugar estimation is required and must be documented.

5. Measurement of urine output or body weight is mandatory. Daily body weight measurement will accurately assess free fluid but is not feasible in the surgical bed bound child with acute pain. Urine output must be measured and clearly documented. An experienced doctor must assess fluid balance at least twice daily and take appropriate action to correct fluid loss or retention. If urine output is problematic a urinary sodium, potassium and urea should be measured.

6. Care must be exercised when additional fluids are administered as this may seriously complicate the maintenance fluid regimen. Intravenous antibiotics, oral fluids or contrast media are commonly forgotten additional fluids.

Intravenous Fluid Prescription

Infants less than 1 year of age.

Dilutional Hyponatraemia does not appear to be a common problem in this age group. Blood chemistry and monitoring of fluid balance is as described above.

For normal serum sodium (Na^+ 135-145 mmol/l)

Give 0.18% NaCl in 4% Glucose at a rate of 4 mls per kg body weight per hour. *Eg For a 5 kg infant this is 20 mls per hour.*

For low or high sodium expert advice should be sought.

Children greater than 1 year of age.

Dilutional Hyponatraemia is well documented in this age group. Blood chemistry and monitoring of fluid balance is as described above.

For normal serum sodium (Na^+ 135-145 mmol/l)

Give 0.45% NaCl in 2.5% Glucose at a rate as above.

For low or high sodium expert advice should be sought.

REFERENCES

Arieff AI. Postoperative hyponatraemic encephalopathy following elective surgery in children. *Paediatric Anaesthesia* 1998;8:1-4

Halperin M et al. Acute hyponatraemic in children admitted to hospital. *BMJ* 2001;322:780-2