Fluids in Paediatrics

Background knowledge

- Intravenous fluids can be especially dangerous in children, and oral rehydration solution orally or via nasogastric route should be used wherever possible.
- Urine output should be:
  - <2 years old: >2ml/kg/h
  - >2 years old: >1ml/kg/h
- The two reasons for IV fluids should be thought about separately:
  - Maintenance fluids are required if a patient is nil by mouth (full maintenance) or not drinking enough ('% of maintenance' depending on intake).
  - Dehydration fluids are required if there is an existing fluid deficit.
- Anyone on prolonged IV fluids should have an accurate fluid balance chart, regular weights and regular electrolytes.
- All paediatric fluid bags come in 500ml volumes as standard.

Maintenance fluids in children (except neonates)

Fluid requirements

<table>
<thead>
<tr>
<th>Total daily fluid requirements (over 24 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st 10kg of bodyweight: 100ml/kg/day</td>
</tr>
<tr>
<td>2nd 10kg of bodyweight: 50ml/kg/day</td>
</tr>
<tr>
<td>Remainder of bodyweight: 20ml/kg/day</td>
</tr>
</tbody>
</table>

Rate (ml/h) = total daily requirement ÷ 24

Example: a 27kg child's maintenance requirements would be:

- Total daily requirement:
  - 1st 10kg = 100ml/kg/day = 1000ml
  - 2nd 10kg = 50ml/kg/day = 500ml
  - Rest (i.e. 7kg) = 20ml/kg/day = 140ml
  - TOTAL = 1640ml/day

- Rate = 1640 ÷ 24 = 68ml/hour

Electrolyte requirements

- Sodium = 2-4mmol/kg/day (but this ‘requirement’ of sodium is ignored because it was based on a study involving healthy, overweight American children with high-salt diets; 0.9% saline+5% dextrose has now been proven to be the safest maintenance fluid in hospitalised children).
- Potassium = 1-2mmol/kg/day (but the fluid type below (500ml bag with 10mmol KCl) at the rate above will give the right amount of potassium in most cases).

Fluid type

The fluid type that is usually used for maintenance is 500ml 0.9% saline + 5% dextrose with 10mmol KCl (all in the same bag) – there are different concentrations of potassium available if required.

Maintenance fluids in neonates

Fluid requirements

- Day 1: 60ml/kg/day
- Day 2: 90ml/kg/day
- Day 3: 120ml/kg/day
- Day 4 and after: 150ml/kg/day

The formula above still applies – work out their total daily requirement first, then dived by 24 to get the hourly infusion rate.

Notes:
- Small or premature infants require more fluids due to higher insensible losses (extra 20ml/kg/day if <1.5kg, extra 40ml/kg/day if <1kg).
- If the baby weighs less than their birth weight, use the birth weight to calculate their fluid requirement.
- If the baby is: <1kg measure electrolytes 8-12 hourly for 3-4 days then daily; <1.5kg 12 hourly for 3-4 days then daily; >1.5kg daily.
- Weigh all babies daily.

Electrolyte requirements

These are very important in neonates and are added to the bag manually. Electrolyte requirements depend on their electrolyte results but average requirements are:
**Electrolyte abnormalities**

Hypo/hypernatraemia

Special situations

**Ongoing**

Severe

Moderate

Mild

Dehydration fluids

- Dehydration severity
- Total days the bag will run over
- Electrolyte additive required
- Total days the bag will run over

Calculation of electrolyte additives

Can be complex because you need to calculate the concentration of electrolytes needed to be added to 500ml to give their requirements over 24 hours, taking into account that the 500ml may run over more/less than 24 hours...

1. Work out the total daily fluid requirement
2. Work out the total daily sodium and potassium requirement
3. Because the fluid comes in 500ml bags, the additives required can be calculated by:
   a. Total days the bag will run over = 500ml ÷ daily fluid requirement
   b. Electrolyte additive required = total days the bag will run over x daily electrolyte requirement

Work it out for sodium and potassium separately

**Dehydration fluids**

Existing dehydration correction

<table>
<thead>
<tr>
<th>Dehydration severity</th>
<th>Deficit (ml/kg)</th>
<th>Clinical features</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>50ml/kg (5% body weight)</td>
<td>Slightly dry mucus membranes, increased thirst, slightly decreased urine output</td>
<td>Oral/NG rehydration solution (1-1.5x maintenance) OR: IV maintenance</td>
</tr>
<tr>
<td>Moderate</td>
<td>100ml/kg (10% body weight)</td>
<td>Dry mucus membranes, tachycardia, reduced urine output, loss of skin turgor, sunken eyes/fontanelle</td>
<td>IV bolus OR: NG fluids at 25ml/kg/h for first 4 hours; oral rehydration solution</td>
</tr>
<tr>
<td>Severe</td>
<td>150ml/kg (15% body weight)</td>
<td>As in moderate but also: pronounced tachycardia, weak pulse, hypotension, delayed capillary refill, mottled skin/cyanosis, dyspnoea</td>
<td>IV bolus (may need multiple)</td>
</tr>
</tbody>
</table>

- A fluid bolus of **10-20ml/kg 0.9% saline** may be given STAT to replace a significant fluid deficit
- Only moderate-severe dehydration should be corrected with an IV fluid bolus (because a fluid bolus is not without risk in children)
- The aim of a bolus is to restore blood pressure and perfusion
- Boluses should be used to reduce moderate/severe dehydration to a deficit of ~80ml/kg (8% body weight) – below which blood pressure and perfusion are adequate
  - e.g. in moderate dehydration, a 20ml/kg bolus will reduce a 100ml/kg deficit to an 80ml/kg deficit
  - In severe dehydration, repeat 20ml/kg boluses may be required
- Mild dehydration, or the remaining deficit, should be corrected with oral or NG rehydration solution, or by IV fluids aiming to correct the deficit over 24-48 hours (in addition to normal maintenance if that is also required). However, unless the patient is strictly nil by mouth, maintenance rate is usually adequate, because they will start drinking again when they’ve ‘turned the corner’
- Oral rehydration solution fluid challenge (for mild-moderate gastroenteritis) =
  - 1-2ml/kg of oral rehydration solution every 10 minutes
  - Give parents chart to fill in
  - 20ml/kg of oral fluid in 2 hours = adequate (if not, child may need admission)

**Ongoing losses correction**

- Estimate rate of loss and replace at the same rate
- If you are replacing a particular loss which is being measured (e.g. stoma loss), you can prescribe the fluid as “ml for ml of stoma loss”
- The type of fluid depends on the fluid lost
  - Extracellular fluid losses (e.g. GI losses) = most similar to 500ml 0.9% saline with 13.5mmol KCl
  - Fever = same type of fluids as normal maintenance fluids (500ml 0.9% saline+5% dextrose with 10mmol KCl)
- If patient is on maintenance fluids and requires extra to correct losses/deficit you can quantify extra fluids as ‘maintenance + 5/10/15%’

**Special situations**

Hypo/hypernatraemia

- Correct the fluid deficit slowly (e.g. over 48 hours) unless the patient is shocked
- Seek senior advice

Electrolyte abnormalities

- See common paediatric prescriptions

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