Intravenous Fluid Guidelines for children aged 0-17 years on the Paediatric Unit

Following recommendations from NICE 2015 (NG29)

Cautions: When on NICU/SCBU please follow Neonatal Guidelines

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Author Dr Fiona MacCarthy
Date Ratified November 2016
Next Review November 2021
### Table 1 Clinical features of dehydration and hypovolaemic shock

<table>
<thead>
<tr>
<th>No clinically detectable dehydration</th>
<th>Clinical dehydration</th>
<th>Hypovolaemic shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert and responsive</td>
<td><strong>Red flag</strong></td>
<td>Decreased level of consciousness</td>
</tr>
<tr>
<td></td>
<td>Altered responsiveness (for example, irritable, lethargic)</td>
<td></td>
</tr>
<tr>
<td>Appears well</td>
<td><strong>Red flag</strong></td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Appears to be unwell or deteriorating</td>
<td></td>
</tr>
<tr>
<td>Eyes not sunken</td>
<td><strong>Red flag</strong></td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Sunken eyes</td>
<td></td>
</tr>
<tr>
<td>Moist mucous membranes (except after a drink)</td>
<td>Dry mucous membranes (except for ‘mouth breather’)</td>
<td>–</td>
</tr>
<tr>
<td>Normal blood pressure</td>
<td>Normal blood pressure</td>
<td>Hypotension (decompensated shock)</td>
</tr>
<tr>
<td>Normal breathing pattern</td>
<td><strong>Red flag</strong></td>
<td>Tachypnoea</td>
</tr>
<tr>
<td></td>
<td>Tachypnoea</td>
<td></td>
</tr>
<tr>
<td>Normal capillary refill time</td>
<td>Normal capillary refill time</td>
<td>Prolonged capillary refill time</td>
</tr>
<tr>
<td>Normal heart rate</td>
<td><strong>Red flag</strong></td>
<td>Tachycardia</td>
</tr>
<tr>
<td></td>
<td>Tachycardia</td>
<td></td>
</tr>
<tr>
<td>Normal peripheral pulses</td>
<td>Normal peripheral pulses</td>
<td>Weak peripheral pulses</td>
</tr>
<tr>
<td>Normal skin turgor</td>
<td><strong>Red flag</strong></td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Reduced skin turgor</td>
<td></td>
</tr>
<tr>
<td>Normal urine output</td>
<td>Decreased urine output</td>
<td>–</td>
</tr>
<tr>
<td>Skin colour unchanged</td>
<td>Skin colour unchanged</td>
<td>Pale or mottled skin</td>
</tr>
<tr>
<td>Warm extremities</td>
<td>Warm extremities</td>
<td>Cold extremities</td>
</tr>
</tbody>
</table>

**Notes:**
Within the category of ‘clinical dehydration’ there is a spectrum of severity indicated by increasingly numerous and more pronounced clinical features. For hypovolaemic shock, 1 or more of the clinical features listed would be expected to be present. Dashes (–) indicate that these features do not specifically indicate hypovolaemic shock.
This table has been adapted from the assessing dehydration and shock section in ‘Diarrhoea and vomiting in children’ (NICE guideline CG84).
**Algorithm 1: Assessment and monitoring**

- **Does the patient need fluid resuscitation?**
  - Yes
    - **Can the patient meet their fluid and/or electrolyte needs enterally?**
      - Yes
        - Provide fluid and electrolytes enterally
      - No
        - **Is an accurate calculation of insensible losses important (for example, weight above 91st centile, acute kidney injury, known chronic kidney disease or cancer)?**
          - Yes
            - Consider using body surface area to calculate IV fluid and electrolyte needs
          - No
            - **Use body weight to calculate IV fluid and electrolyte needs**
  - No
    - **Record assessment and monitoring criteria on the fluid balance and prescription chart**

- **Measure plasma electrolyte concentrations using laboratory tests when starting IV fluids, and then at least every 24 hours**

- **Risk of hypoglycaemia?**
  - Yes
    - Measure blood glucose more frequently than every 24 hours
  - No
    - **Time critical situation (for example, emergency, A&E, theatre, critical care)?**
      - Yes
        - Consider using point-of-care testing for plasma electrolyte concentrations and blood glucose
      - No
        - **Measure blood glucose at least every 24 hours**

- **Look for clinical dehydration and hypovolaemic shock**

- **Patient needs fluids for routine maintenance**

- **Patient has complex fluid or electrolyte replacement or abnormal distribution issues**

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**Algorithm 2: Fluid resuscitation**

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**Algorithm 3: Routine maintenance**

**Algorithm 4: Replacement and redistribution**
**Algorithm 2: Fluid resuscitation**

Term neonate, child or young person requires IV fluid resuscitation?

- **No**
  - Pre-existing condition (for example, cardiac or kidney disease)?
    - **No**
      - Take into account pre-existing conditions as smaller fluid volumes may be required.
    - **Yes**
      - Use glucose-free crystalloids that contain sodium in the range 131–154 mmol/litre, with a bolus of 20 ml/kg over less than 10 minutes for children and young people, and 10–20 ml/kg over less than 10 minutes for term neonates.

- **Yes**
  - Reassess after bolus completed

**Algorithm 1: Assessment and monitoring**

Seek expert advice (for example, from the paediatric intensive care team) if 40–60 ml/kg or more is needed as part of the initial fluid resuscitation.
**Algorithms for IV fluid therapy in children and young people in hospital**

### Algorithm 3: Routine maintenance

Measure plasma electrolyte concentrations and blood glucose when starting IV fluids (except before most elective surgery) and at least every 24 hours thereafter.

**Term neonate**

**Child or young person**

**Please see Neonatal addendum**

**Calculate routine maintenance IV fluid rates using the following as a guide:**
- From birth to day 1: 50–60 ml/kg/day
- Day 2: 70–80 ml/kg/day
- Day 3: 80–100 ml/kg/day
- Day 4: 100–120 ml/kg/day
- Day 5–28: 120–150 ml/kg/day

**Is the neonate in a critical postnatal adaptation phase (for example respiratory distress syndrome, meconium aspiration, hypoxic ischaemic encephalopathy)?**

- **No**
  - Initially use isotonic crystalloids that contain sodium in the range 131–154 mmol/litre with 5–10% glucose

- **Yes**
  - Give no or minimal sodium until postnatal diuresis with weight loss occurs

**When using body surface area to calculate needs, estimate insensible losses within the range 300–400 ml/m²/24 hours plus urinary output**

**Calculate routine maintenance IV fluid rates for children and young people using the Holliday–Segar formula:**
- 100 ml/kg/day for the first 10 kg of weight
- 50 ml/kg/day for the second 10 kg of weight
- 20 ml/kg/day for the weight over 20 kg
- Be aware that over a 24-hour period, males rarely need more than 2500 ml and females rarely need more than 2000 ml

**Initially use isotonic crystalloids that contain sodium in the range 131–154 mmol/litre**

**Risk of water retention associated with non-osmotic antidiuretic hormone secretion?**

- **No**
- **Yes**

**Consider either:**
- restricting fluids to 50–80% of routine maintenance needs or
- reducing fluids, calculated on the basis of insensible losses within the range 300–400 ml/m²/24 hours plus urinary output

**Base any subsequent IV fluid prescriptions on the plasma electrolyte concentrations and blood glucose measurements**
Neonatal Fluids

- For Neonates on Day 1: 60ml/kg/day of 10% Dextrose, Day 2: 90ml/kg, Day 3: 120ml/kg, Day 4: 150ml/kg.
- When diuresis has occurred Sodium and other electrolytes can be considered for addition (this gives 4mg/kg/min)
- In a cooled baby (who is in critical postnatal adaptation phase and has reduced metabolic demands) 40ml/kg/day 10% Dextrose gives an acceptable 3mg/kg/min

For a newborn baby the postnatal adaptation of glucose control is critical in the unwell infant. We have an on-line calculator here:

- **Glucose calculator**
  
  http://trustnet/docsdata/paed/formulary/Dextrose_Infusion_Calculator.html
Algorithm 4: Replacement and redistribution

Adjust the IV fluid prescription to account for existing fluid and/or electrolyte deficits or excesses, ongoing losses or abnormal distribution.

Consider isotonic crystalloids that contain sodium in the range 131–151 mmol/litre for redistribution.

Need to replace ongoing losses?

No

Use 0.9% sodium chloride containing potassium to replace ongoing losses.

Yes

Base subsequent fluid composition on plasma electrolyte concentrations and blood glucose measurements.
Algorithm 5: Managing hypernatraemia (plasma sodium more than 145 mmol/litre) that develops during IV fluid therapy

If hypernatraemia develops, review the fluid status

Fluid status uncertain?

No

Yes

Measure urine sodium and osmolality

Evidence of dehydration?

No

If using an isotonic solution, consider changing to a hypotonic solution (for example, 0.45% sodium chloride with glucose)

Yes

Calculate the water deficit and replace it over 48 hours, initially with 0.8% sodium chloride

Ensure the rate of fall of plasma sodium does not exceed 12 mmol/litre in a 24-hour period

Hyponatraemia worsening or unresponsive?

No

Yes

Measure plasma electrolyte concentrations every 4–6 hours for the first 24 hours, and after this base the frequency of further plasma electrolyte measurements on the treatment response
Diagram of ongoing losses for children
INTRAVENTOUS FLUID TYPES

<table>
<thead>
<tr>
<th>Fluid type</th>
<th>Osmolality (compared with plasma)</th>
<th>Tonicity (with reference)</th>
<th>Sodium content (mmol/l)</th>
<th>Potassium content (mmol/litre)</th>
</tr>
</thead>
</table>

INTRAVENOUS FLUID TYPES

<table>
<thead>
<tr>
<th>Osmolality (compared with plasma)</th>
<th>Tonicity (with reference)</th>
<th>Sodium content (mmol/l)</th>
<th>Potassium content (mmol/litre)</th>
</tr>
</thead>
</table>

10
<table>
<thead>
<tr>
<th>Fluid</th>
<th>Osmolarity</th>
<th>Tonicity</th>
<th>Litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9% sodium chloride</td>
<td>Isosmolar</td>
<td>Isotonic</td>
<td>154</td>
</tr>
<tr>
<td>Hartmann’s solution</td>
<td>Isosmolar</td>
<td>Isotonic</td>
<td>131</td>
</tr>
<tr>
<td>0.9% sodium chloride with 5% glucose</td>
<td>Hyperosmolar</td>
<td>Isotonic</td>
<td>150</td>
</tr>
<tr>
<td>0.45% sodium chloride with 5% glucose</td>
<td>Hyperosmolar</td>
<td>Hypotonic</td>
<td>75</td>
</tr>
<tr>
<td>0.45% sodium chloride with 2.5% glucose</td>
<td>Isosmolar</td>
<td>Hypotonic</td>
<td>75</td>
</tr>
<tr>
<td>0.45% sodium chloride</td>
<td>Hyposmolar</td>
<td>Hypotonic</td>
<td>75</td>
</tr>
<tr>
<td>5% glucose</td>
<td>Isosmolar</td>
<td>Hypotonic</td>
<td>0</td>
</tr>
<tr>
<td>10% glucose</td>
<td>Hyperosmolar</td>
<td>Hypotonic</td>
<td>0</td>
</tr>
</tbody>
</table>

**SPECIALIST INTRAVENOUS FLUIDS**
1) **DEXTROSE:**

**Tip: Glucose calculator on Trust Neonatal Guidelines!**

- The basal requirement of most newborn infants is 6-8mg/kg/min
- Hypoglycaemia is severe if it persists despite an intake of >10mg/kg/min

Calculate the glucose intake:

\[
\text{Glucose intake (mg/kg/min)} = \frac{\% \text{Dextrose} \times \text{Hourly Rate}}{\text{Weight (kg)} \times 6}
\]

Or

\[
\text{Glucose intake (mg/kg/min)} = \frac{\% \text{Dextrose} \times \text{Volume}}{144}
\]

<table>
<thead>
<tr>
<th>Intake (ml/kg/day)</th>
<th>5% Dextrose mg/kg/min Dextrose</th>
<th>10% Dextrose mg/kg/min Dextrose</th>
<th>12.5% Dextrose mg/kg/min Dextrose</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>2.1</td>
<td>4.2</td>
<td>5.2</td>
</tr>
<tr>
<td>75</td>
<td>2.6</td>
<td>5.2</td>
<td>6.5</td>
</tr>
<tr>
<td>90</td>
<td>3.1</td>
<td>6.3</td>
<td>7.8</td>
</tr>
<tr>
<td>105</td>
<td>3.7</td>
<td>7.3</td>
<td>9.1</td>
</tr>
<tr>
<td>120</td>
<td>4.2</td>
<td>8.3</td>
<td>10.4</td>
</tr>
<tr>
<td>150</td>
<td>5.2</td>
<td>10.4</td>
<td>13.0</td>
</tr>
<tr>
<td>180</td>
<td>6.3</td>
<td>12.5</td>
<td>15.6</td>
</tr>
</tbody>
</table>

a) **To get concentrated glucose solutions:**
<table>
<thead>
<tr>
<th>Solution</th>
<th>10% Dextrose</th>
<th>50% Dextrose</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5%</td>
<td>450ml</td>
<td>30ml</td>
</tr>
<tr>
<td>15%</td>
<td>420ml</td>
<td>60ml</td>
</tr>
<tr>
<td>20%</td>
<td>400ml</td>
<td>135ml</td>
</tr>
<tr>
<td>Solution</td>
<td>5% Dextrose</td>
<td>50% Dextrose</td>
</tr>
<tr>
<td>7.5%</td>
<td>450ml</td>
<td>30ml</td>
</tr>
</tbody>
</table>

- The maximum safe concentration of peripheral dextrose is 12.5% any more than this should go through a central line
- Peripheral ivs do not last long and extravasation can result in tissue damage

**b) Glucose infusions for known metabolic patients**

- Always refer to the patient’s own protocol

- Read the instructions very carefully, checking each step. Discuss with the Consultant. Liaise with Evelina Children’s Hospital Metabolic team if any concerns.

**0.9% Saline 10% glucose 500ml bag**

a) Remove and discard 50ml from a 500ml 5% glucose 0.9% Sodium Chloride  

b) To the remainder of the bag add 50ml of 50% glucose

**0.45% Saline 10% glucose 500ml bag**

a) Remove and discard 50ml from 500ml bag of 5% glucose 0.45% Sodium Chloride  

b) To the remainder of the bag add 50ml of 50% glucose
0.45% Saline 5% glucose 500ml bag (usually readily available!)

a) Remove and discard 50ml from a 500ml 0.45% saline
b) To the remainder of the bag add 50ml of 50% glucose

0.45% Saline 2.5% glucose 500ml bag - For GLUT 1 deficiency only

a) Remove 25ml from a 500ml bag of 0.45% saline
b) To the remainder of the bag add 25ml of 50% glucose

0.18% Saline 10% glucose 500ml bag (specialist advice only)

a) Using a 500ml bag of 10% glucose
b) add 3ml of 30% sodium chloride concentrate. **Measure the sodium chloride very carefully**

References:

3) NICE 2015 NG29 fluid guidelines