<table>
<thead>
<tr>
<th><strong>Title:</strong></th>
<th>Guideline for the perioperative fluid management in children</th>
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</thead>
<tbody>
<tr>
<td><strong>Author:</strong></td>
<td>Kieran O’Connor</td>
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<td><strong>Speciality / Division:</strong></td>
<td>Anaesthetics</td>
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<td><strong>Directorate:</strong></td>
<td>ATICS</td>
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<td>July 2022</td>
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<td><strong>Clinical Guideline ID:</strong></td>
<td>CG0008 [3]</td>
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</table>
Guideline for the perioperative fluid management in children

This local guideline has been developed to provide guidance and reduce the risk of harm associated with intravenous fluid administration to the paediatric patient in the perioperative phase. **It is important to remember that guidelines provide guidance only and that clinical acumen and judgement are also important factors in patient care.** It is not intended to replace existing SHSCT policies and procedures and should be used in conjunction with the following:

- Central Repository for HSC Resources relating to Fluid Management in Children and Young People
- DoH Parenteral fluid therapy for children and young people (Aged over 4 weeks and under 16 years)
- SHSCT Paediatric fluid prescription and calculation sheet
- NICE guidelines: Intravenous fluid therapy in children and young people in hospital; Published Dec 2015

This guideline applies to children over the age of 4 weeks and up to 16 years.

**Background**

- Fasting, surgery and anaesthesia cause stress and alter physiology. Intravenous fluids are administered peri-operatively to maintain homeostasis.

- The vast majority of paediatric surgical patients in SHSCT undergo elective minor surgery which often lasts less than an hour. Many children will re-establish oral intake in the early postoperative phase and therefore may not need routine intravenous fluids. If fasted appropriately i.e. ensuring children are not left without fluid intake for longer than necessary, then there will be a minimal fluid deficit which does not need corrected. In elective surgery clear fluids can safely be allowed up to 2hrs preoperatively.\(^2,^3\)

- Inappropriate fluid administration with either incorrect volumes or incorrect fluid type increases the risk of harm to the patient including the risk of hyponatraemia\(^4,^5\) and therefore fluids should only be administered if clinically indicated.

- There is some evidence that intraoperative fluid therapy reduces the incidence of post-op nausea and vomiting (PONV).\(^6\)
- If fluids are deemed to be clinically indicated, management should be divided into 3 parts

1. Replacement of fluid deficit  
2. Administration of maintenance fluid  
3. Replacement of any loss

1. Rehydration/Replacement:

- An otherwise healthy child fasted preoperatively will have a fluid deficit, although if fasted appropriately this will be minor and will usually not need to be corrected.

- If clinically dehydrated, the patient should be assessed using the table below however it should be remembered precise calculation using clinical signs is usually inaccurate. The best method relies on the difference between the current body weight and the immediate pre-morbid body weight, which is often unavailable.

<table>
<thead>
<tr>
<th>Degree of Dehydration</th>
<th>Signs are ordered in each column by severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate, 5%</td>
<td>Dry mucous membranes (be wary in the mouth breather) Diminished skin turgor (pinch test 1-2 sec) Altered neurological status (drowsiness, irritability) Deep (acidotic) breathing</td>
</tr>
<tr>
<td>Severe, 8%</td>
<td>Decreased peripheral perfusion Cool/mottled/pale peripheries Capillary refill time &gt; 2 sec Circulatory collapse</td>
</tr>
</tbody>
</table>

Do not use more than 8% dehydration in calculation.

Table from SHCST Paediatric fluid calculation sheet**

- Dehydration without signs of hypovolaemia should be corrected slowly

- Hypovolaemia should be corrected rapidly to maintain cardiac output and organ perfusion

- Use glucose free crystalloids that contain sodium in the range of 131-154 mmol/litre

- A straightforward correction of a potential fluid deficit (without overt hypovolaemia) would be to give an initial bolus of 10ml/kg of isotonic fluid within the first hour. This is supported by the APA consensus 2007.
"Consensus was not obtained on management of fluid deficit in children undergoing major surgery. Whilst it was felt that in elective cases the fluid deficit should be no greater than that of children having minor surgery, many would give an initial bolus of 10ml/kg in the first hour to correct it."

A more accurate calculation, if necessary, is as follows:

**Replacement: Redistribution**

<table>
<thead>
<tr>
<th>ESTIMATE DEFICIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLUID DEFICIT = (% dehydration x kg x 10) as mls of:</td>
</tr>
<tr>
<td>Isotonic crystalloids that contain sodium in the range 131 - 154 mmol/L</td>
</tr>
</tbody>
</table>

The volume of fluid to be prescribed is: fluid deficit MINUS volume of any fluid bolus received. Prescribe this residual volume of deficit separately from the maintenance prescription.

Give over 48 hours.

**ONGOING LOSSES:** calculate at least 4 hourly. Replace with an equal volume of: sodium chloride 0.9% (with pre-added potassium).

Change fluid type and volume according to clinical reassessment, electrolyte losses and test results.

**A fluid deficit in a previously well child fasting for elective surgery may also be calculated by:**
- multiplying the hourly maintenance requirement (see maintenance fluid calculations) by the number of hours starved.
- The deficit can be replaced with 50% in the first hour of surgery, and 25% in each of the subsequent two hours.

**2. Administration of maintenance fluid:**
- Maintenance fluid requirements should be calculated according to the recommendations of Holliday and Segar\(^7\) for children and infants older than 4 weeks of age, using body weight: "The 4/2/1 rule"

**Routine Maintenance [Uses Weight]**

<table>
<thead>
<tr>
<th>CALCULATION OF 100% RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) for first 10 kg: 4ml/kg/hr</td>
</tr>
<tr>
<td>(b) for second 10 kg: 2ml/kg/hr</td>
</tr>
<tr>
<td>(c) for each kg over 20 kg: 1ml/kg/hr</td>
</tr>
</tbody>
</table>

[for 100% daily maintenance add together (a) + (b) + (c)]

MAXIMUM: females 80 mls per hour; males 100mls per hour.

If risk of hyponatraemia is high consider initially reducing maintenance volume to two thirds of maintenance.

**DOH Wallchart PARENTERAL FLUID THERAPY FOR CHILDREN & YOUNG PEOPLE (AGED OVER 4 WEEKS & UNDER 16 YEARS) (see Appendix 3)**
3. Replacement of ongoing losses

- Ongoing losses due to evaporation from an open wound or via the humidification of dry inspired gases, bleeding, pyrexia, gastrointestinal and third space losses (fluid leak into tissues) during surgery and into the post-operative period should be carefully monitored and estimated at least 4 hourly.

**Fluids to be used in theatre environment:**

- The fluid used to replace any fluid deficit should be isotonic – 0.9% sodium chloride or Hartmann’s solution are the safest fluids to use within the theatre environment.
- The majority of children over 1 month of age will maintain a normal blood sugar if given non-dextrose containing fluid during surgery.

**Documentation:**

From APA consensus guideline on perioperative fluid management in children (2007)²

- All fluid intake should be recorded on a fluid balance sheet
- Serum electrolytes do not need to be measured pre-operatively in healthy children prior to elective surgery where IV fluids are to be given
- Serum electrolytes need to be measured pre-operatively in all children presenting for elective or emergency surgery who require IV fluid to be administered prior to surgery. Children should be weighed prior to fluids being prescribed and given
- Serum electrolytes should be measured every 24 hours in all children on IV fluids or more frequently if abnormal
- Although ideally children should be weighed daily while on IV fluids, practically this is difficult in older children, or those who have undergone major surgery
- Use of a fluid input/output chart will help with fluid management

In SHSCT the appropriate documentation must be completed with clear signatures/dates/times when fluids are administered and prescribed. This includes any ongoing IV fluids deemed necessary when transferred back to the surgical ward.

- SHSCT Paediatric fluid prescription chart and calculation sheet (Appendix 1)
- SHSCT Paediatric fluid input and output monitoring sheet (Appendix 2)
**Guideline for peri-operative fluid management in children**

**Does this child require IV fluids?**

IN SHCST the majority of paediatric patients will **not** require perioperative IV fluids particularly if

- They are fasted appropriately
- The planned surgical procedure is short e.g. lasts less than one hour
- Intraoperative blood or fluid losses are minimal

Paediatric patients presenting electively should therefore be encouraged to have an oral intake of clear fluids up to 1 hour preoperatively.

Fluids may be clinically indicated if there will be a delay in re-establishing oral intake post operatively e.g. post-op tonsillectomy or administered to decrease PONV.

**If fluids are clinically indicated:**

- An isotonic & non glucose containing solution such as Hartmann's solution or 0.9% normal saline should be used
- Fluid deficit replacement can be given as a **10ml/kg bolus** in the first instance
- Fluids should ideally be given via a pump giving set through a pump to ensure accurate delivery of fluids. (They should not be administered via a buritrol or blood giving set as it is more difficult to measure exact volume)
- To avoid potential error and harm
  - Paracetamol should ideally be given via a pump or the appropriate dose drawn up in a syringe and administered to avoid delivering too large a dose to children under 50kg
  - Use intravenous fluids from 500ml bags (not 1000ml bags)
- **All fluid given must** be documented with legible signatures/ date /time /weight
  - Anaesthetic chart
  - Up to date SHSCT Paediatric fluid prescription and calculation sheet
  - Fluid input/output chart must be used

If fluid are required postoperatively

- Maintenance requirements **must** be calculated and documented
- Fluids prescribed by the anaesthetist must be appropriate to the patient; therefore in the immediate post-operative phase isotonic fluids should again be used

**This will be audited by the ATICS Specific PIVFAIT Tool (Appendix 4)**

On-going fluid prescription and management in the post-operative stage, though initially prescribed by the anaesthetist, should remain the responsibility of the combined surgical/paediatric team, with support from the anaesthetist if necessary.
References:


7. Holliday MA, Segar WE. The maintenance need for water in parenteral fluid therapy. Paediatrics 1957;19:823-832

8. NICE guidelines [NG29]: Intravenous fluid therapy in children and young people in hospital; Published Dec 2015. https://www.nice.org.uk/guidance/ng29
Appendix 1: SHSCT Paediatric fluid prescription chart and calculation sheet
Appendix 2: SHSCT Paediatric fluid input and output monitoring sheet

<table>
<thead>
<tr>
<th>Time</th>
<th>Fluid Input (ml)</th>
<th>Fluid Output (ml)</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:00</td>
<td>300</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>09:00</td>
<td>300</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>19:00</td>
<td>300</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>20:00</td>
<td>300</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>21:00</td>
<td>300</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>22:00</td>
<td>300</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- **Fluid Input (ml)**: Volume of fluid received.
- **Fluid Output (ml)**: Volume of fluid lost.
- **Balance**: Cumulative fluid balance over time.

**Notes:**
- Include all sources of fluid input and output.
- Update hourly as necessary.
- Monitor fluid balance to ensure hydration is maintained.

**Dosage:**
- Ensure fluid balance is maintained within normal limits.
- Adjust fluid intake and output as needed based on patient status.

**Special Instructions:**
- Monitor closely for signs of dehydration or overhydration.

**Hospital**: [Hospital Name]

**Ward**: [Ward Number]

**Date**: [Date of Monitoring]
PARENTERAL FLUID THERAPY FOR CHILDREN & YOUNG PEOPLE (AGED OVER 4 WEEKS & UNDER 16 YEARS)

Resuscitation
ADMINISTER FLUID BOLUS OVER LESS THAN 10 MINUTES
Give 20 ml/kg of glucose-free crystalloids that contain sodium in the range 131 - 154 mmol/L IV or intraosseous
[10 ml/kg if history of trauma, haemorrhage or in diabetic ketoacidosis]
Reassess. Repeat bolus if needed and get senior help.

Can child be managed with enteral fluids?
YES
PRESCRIBE ENTERAL REHYDRATION SOLUTION

Replacement: Redistribution
ESTIMATE DEFICIT
FLUID DEFICIT = (% dehydration x kg x 10) as ml of:
 isotonic crystalloids that contain sodium in the range 131 - 154 mmol/L
The volume of fluid to be prescribed is: fluid deficit MINUS volume of any fluid bolus received
Prescribe this residual volume of deficit separately from the maintenance prescription.

GIVE OVER 48 HOURS:
ONGOING LOSSES: calculate at least 4 hourly. Replace with an equal volume of:
sodium chloride 0.9% (with pre-added potassium)
Change fluid type and volume according to clinical reassessment, electrolyte losses and test results

Routine Maintenance
Fluid choices:
Initially use isotonic crystalloids that contain sodium in the range of 131 - 154 mmol/L. Glucose containing fluid required in infants and young children. May also be required in older children.

Fluid Rate:
Alter fluid rate according to clinical reassessment (including changes in enteral intake). Adjust fluid type according to investigations. If sodium rises above 145 mmol/L change to sodium chloride 0.45% (with or without pre-added glucose and potassium).

Profile for Fluid Therapy

DOH Wallchart PARENTERAL FLUID THERAPY FOR CHILDREN & YOUNG PEOPLE

Appendix 3:
K O'Connor (Cons Anaesthetist) A Steele (CT2) v3 (revised July 2019)
## Appendix 4: ATICS Specific PIVFAIT Tool

<table>
<thead>
<tr>
<th>Date of Birth</th>
<th>Hospital number</th>
<th>Date commenced</th>
<th>Theatre / Recovery place</th>
<th>Fluid balance chart prior to Theatre / Recovery</th>
<th>Fluid balance chart during Theatre / Recovery</th>
<th>Fluid balance chart post Theatre / Recovery</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please note if the child confirms to receive IV fluids outside the Theatre / Anaesthetics setting then the Ward is to complete the full chart.

### Daily Fluid Balance & Description Chart

- **Type of fluid:** 
  - lactic acidosis
  - hypocalcemia
  - hypokalemia
  - metabolic acidosis
  - metabolic alkalosis
  - non-cardiogenic pulmonary edema
  - hyperkalemia
  - hypoglycemia
  - hyperbilirubinemia
  - hepatic failure
  - diuretic therapy
  - hypervolemia
  - hypovolemia
  - endotoxemia
  - liver failure
  - ventilator dependent

- **Type of fluid:** 
  - hypocalcemia
  - hypokalemia
  - metabolic acidosis
  - metabolic alkalosis
  - non-cardiogenic pulmonary edema
  - hyperkalemia
  - hypoglycemia
  - hyperbilirubinemia
  - hepatic failure
  - diuretic therapy
  - hypervolemia
  - hypovolemia
  - endotoxemia
  - liver failure
  - ventilator dependent

- **Volume of fluid:** 
  - lactic acidosis
  - hypocalcemia
  - hypokalemia
  - metabolic acidosis
  - metabolic alkalosis
  - non-cardiogenic pulmonary edema
  - hyperkalemia
  - hypoglycemia
  - hyperbilirubinemia
  - hepatic failure
  - diuretic therapy
  - hypervolemia
  - hypovolemia
  - endotoxemia
  - liver failure
  - ventilator dependent

### ATICS Specific PIVFAIT Tool

- **Patient identification:** 
  - Name of patient
  - Date of birth
  - Hospital number

- **Fluid balance:** 
  - Lactic acidosis
  - Hypocalcemia
  - Hypokalemia
  - Metabolic acidosis
  - Metabolic alkalosis
  - Non-cardiogenic pulmonary edema
  - Hyperkalemia
  - Hypoglycemia
  - Hyperbilirubinemia
  - Hepatic failure
  - Diuretic therapy
  - Hypervolemia
  - Hypovolemia
  - Endotoxemia
  - Liver failure
  - Ventilator dependent

- **Comments:** 
  - Make note of any changes to fluid balance that occur outside the Theatre / Anaesthetics setting.