IV Fluid Prescribing & Administration

Reference: 1880v1
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Purpose
This guideline is produced in response to NICE guidance to offer up to date, cohesive advice on use of Intravenous (IV) fluids for paediatric in-patients in the Trust.

NB This guideline is NOT for use in DKA, NSU patients, neurosurgical patients, complex post-operative patients and ventilated patients in PCCU. Please refer to the specialist guidelines for those patients.

Intended Audience
This guideline is for use by all nursing, medical, and allied health professionals who are involved in supplying, prescribing and administering intravenous or intra-osseous fluids to patients in the Trust, or those monitoring patients on intravenous/intra-osseous fluid
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1. Introduction

This guideline is produced in response to NICE guidance to offer up to date, cohesive advice on use of IV fluids for paediatric in-patients in the Trust. Many departments have taken different approaches on IV fluids for maintenance, rehydration or resuscitation, both in volumes given, type of fluid, and rigour of monitoring. This has sometimes not been based on current evidence. NICE guidance was released in 2015, offering some clarity on this and especially moving away from use of hypotonic sodium chloride solutions (0.45% sodium chloride) in favour of isotonic fluids (0.9% sodium chloride, Hartmanns, Plasmalyte etc.)

This guidance is for starting initial IV fluids.

All patients on IV fluids should have their fluid requirements reviewed and revised within 12 hours of commencing, and adjusted if required, based on their urea and electrolyte results and their clinical condition.

It is not expected to cover every single clinical situation or eventuality, and particular exceptions will be made clear throughout. Various patient sub-groups have special requirements.

2. Intended Audience

This guideline has been formulated and agreed by a committee including medical, surgical, anaesthetics, emergency and intensive care consultants, senior nursing staff and pharmacy. This guideline is for use by all nursing, medical, allied health, and pharmacy staff who are involved in supplying, prescribing and administering intravenous or intra-osseous fluids to patients in the Trust, or those monitoring patients on intravenous/intra-osseous fluids.

3. Guideline Content

<table>
<thead>
<tr>
<th>NB This guideline is NOT for use in DKA, NSU patients, neurosurgical patients, complex post-operative patients and ventilated patients in PCCU. Please refer to the specialist guidelines for those patients.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DKA – Reg. I.D. 1108</td>
</tr>
<tr>
<td>NSU/PSU – Reg. I.D. 1087 and 938</td>
</tr>
<tr>
<td>Peri-op – Reg. I.D. 740</td>
</tr>
<tr>
<td>PCCU – Reg. I.D. 1689</td>
</tr>
<tr>
<td>Careful consideration should be given to patients with cardiac, nephrotic or metabolic conditions, hepatic or renal failure</td>
</tr>
</tbody>
</table>

There are 3 main reasons for a child to be prescribed IV fluids –

1. Volume resuscitation in shock
2. Maintenance fluid due to low intake or high losses (either due to fasting, vomiting,
1. Volume Resuscitation;

If a patient has signs of hypovolaemic shock – (poor perfusion, tachycardia, drowsy, tachypnea, poor urine output, hypotension, hypotonia) they should immediately receive a 20ml/kg bolus of ISOTONIC, NON-GLUCOSE CONTAINING fluid via an intravenous or intraosseous route.

This will usually be 0.9% Sodium chloride Occasionally another isotonic, non-glucose containing fluid may be used, e.g. Hartmanns or Plasmalyte

The patient must be re-assessed for physiological response after each bolus of fluid.

In trauma, the fluid boluses should be 10ml/kg and the number of boluses given more limited. Stopping haemorrhage and replacing blood and clotting factors are the priorities in these patients. This is covered in APLS, resuscitation and escalation guidelines. (Reg. I.D. 1765/1451)

In DKA, refer to the DKA protocol from the outset.

Caution should be used in patients with known cardiac conditions, renal disease or neonates. The same fluid should be used for resuscitation but in smaller increments of 5ml/kg or 10ml/kg boluses, with rapid re-assessment throughout.

Likewise, while rare in the UK, in severe anaemia or malnutrition, fluid resuscitation requires expert advice.

Expert senior opinion (consultant level) must be sought if a patient requires 40ml/kg or more. This is potentially a sign of fluid-resistant shock and complex management is required.

Blood glucose must always be checked in resuscitation and corrected with 10% glucose IV (2ml/kg) if required. Measure serum electrolytes as soon as is practicable in the resuscitation and correct accordingly.

All resuscitation fluid boluses should be prescribed and recorded with exact times and volumes. Response to boluses should also be documented with full observations.

2. Maintenance fluids;

No child beyond the neonatal period should receive hypotonic fluid as first line maintenance.

Most children on maintenance fluids (fasting or vomiting) will not need 'special' fluid formulae, but certain sub-groups of patients are recognized to have specific fluid needs. These include DKA, neurosurgical patients (both pre-and post-op), neonatal surgical patients, ventilated critical care patients, and some complex medical and surgical patients. These needs are addressed in other guidelines as above.
To calculate typical fluid requirements use the Holliday Segar formula (for neonates see the table later). Do not use any other formula, as this can lead to overprescribing, especially for heavier children.

- Less than 10kg body weight – 100ml/kg per day
- 10-20kg body weight – 1000ml, plus 50ml/kg for each kg over 10kg per day
- Over 20kg body weight – 1500ml, plus 20ml/kg for each kg over 20kg per day. Up to a maximum of 2500ml per day in males and 2000ml per day in females.

Most unwell children are at risk of Syndrome of inappropriate anti-diuretic hormone (SIADH) and fluid retention. It is advised in the first instance to commence any patient on 80% of maintenance with regular, careful review as outlined elsewhere.

- If a child is very overweight for their age, calculate their maintenance based on the 95th weight centile for their age.
- Initial maintenance fluid should be 0.9%sodium chloride with either 5% or 10% glucose included, or Plasmalyte with glucose, for all ages of patient beyond 1 month old, (corrected gestational age).
- Do not use 0.45% sodium chloride, or 0.45% sodium chloride+5% glucose for initial standard maintenance. Current research does not support the use of hypotonic fluids.
- Consider potassium containing fluids within the first 24 hours if there is no oral intake, or if there are ongoing losses.

All patients on IV fluids should have serum electrolytes checked at the beginning of their infusion (except before most elective surgery) and at least every 24hrs thereafter while on IV fluids (laboratory measurements not blood gas machine).

- All patients should have their hourly IV fluid rate recorded.
- All patients should have 12-hrly and 24-hrly fluid balances calculated and recorded.
- All patients on IV fluids should have a daily weight measured. If this is not possible the reason should be documented. This should be compared to the previous day’s weight as part of the assessment of fluid status.
- All patients should have their IV fluids reviewed 12hrly, based on clinical status, fluid balance and recent electrolytes. These should be tailored to each patient’s ongoing requirements.
For neonatal patients outside of NSU:

<table>
<thead>
<tr>
<th>Day of life</th>
<th>Volume (ml/kg/day)</th>
<th>Intravenous fluid composition</th>
<th>Replacement of gastric losses (volume for volume)</th>
<th>Replacement of stoma losses (when greater than 20mls/kg/day)</th>
<th>Replacement for other drain losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 24hrs</td>
<td>60</td>
<td></td>
<td></td>
<td>0.9% sodium chloride</td>
<td>0.15% potassium chloride</td>
</tr>
<tr>
<td>24 – 48hrs</td>
<td>80</td>
<td>10% glucose</td>
<td></td>
<td>5% glucose</td>
<td>As advised by surgical team</td>
</tr>
<tr>
<td>48 – 72hrs</td>
<td>100</td>
<td></td>
<td></td>
<td>(check with consultant re; these additional fluids)</td>
<td></td>
</tr>
<tr>
<td>After 72hrs</td>
<td>120-150</td>
<td>0.45% sodium chloride</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.15% potassium chloride</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% glucose</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Rehydration fluids;

If a child is mildly or moderately dehydrated, attempt if at all possible to rehydrate with oral fluids – as per Diarrhoea and Vomiting Guideline (Medical Guideline Book Ref 1.12)

If possible continue oral fluids as well, during IV rehydration, and include these in any fluid balance calculations.

Remember to differentiate the signs of dehydration and signs of shock as both may be present in some patients but not in most.

Clinically significant dehydration can include:

- Dry mucous membranes
- Reduced skin turgor
- Reduced urine output
- Sunken eyes
- Altered level of responsiveness (irritable, lethargic)

Without shock, these children may be well perfused, but with increased heart rate and respiratory rate.
Fluid management in HYPOntaemia (serum sodium <135)
See algorithm in appendix

Hyponatraemia is rare but symptoms include
- headache
- nausea and vomiting
- confusion
- irritability or lethargy
- convulsions
- coma
- apnoeas

Obtain urgent specialist advice on fluid management
If patient is on hypotonic fluid, change to isotonic fluid.
Restrict maintenance fluids to 50-80% of routine (based on original weight)
If acute symptomatic hyponatraemia is present consider further steps, with consultant input;
- bolus of 2ml/kg 2.7% sodium chloride over 10-15 minutes (max 100ml)
- second bolus of 2ml/kg 2.7% sodium chloride over 10-15 minutes (max 100ml) if symptoms still present
- If symptoms still present after second bolus, recheck serum sodium, and consider third bolus 2ml/kg 2.7% sodium chloride
- Measure serum sodium at least hourly
- As symptoms resolve, frequency of sodium measurement can be reduced.
- After immediate phase, ensure that rate of increase of serum sodium is no more than 0.5mmol/litre/per hour.

Fluid management in HYPERntaemia (serum sodium >145)
See algorithm in appendix

Hypernatraemia is uncommon but suspect it in those with history and signs that seem unusual for straightforward gastroenteritis and if there are any of the following:
- jittery movements
- doughy feel to the skin
- increased muscle tone
- hyperreflexia
- convulsions
- drowsiness or coma.

If dehydrated; Obtain urgent specialist advice on fluid management
Use isotonic solution initially, such as sodium chloride 0.9% with or without glucose 5%
Replace the fluid deficit slowly (usually 48 hours) as rapid rehydration may lead to cerebral oedema.
Aim to reduce serum sodium by no more than 0.5mmol/L per hour.
Monitor plasma sodium 4-8 hourly.
Consider use of hypotonic solution (0.45% sodium chloride with 5/10% glucose) only after careful calculation and monitoring, and with consultant input.

**Fluid calculations in dehydration**

Deficit (replace over 4 hours) + maintenance (give over 24 hours)

Deficit: Mild to moderate dehydration; 50 ml/kg + maintenance
Severe dehydration; 100 ml/kg + maintenance

Do not include resuscitation boluses in ongoing fluid requirement calculations.

Maintenance is calculated as per the Holliday Segar formula above.

- **e.g.** A 15 kg child who shows clinical signs of moderate dehydration would require:
  - Deficit= 50mls/kg over 4 hours = 750 mls (187.5mls/hour for the first 4 hours)
  - Maintenance= (1000ml) + (5×50) = 1250mls over 24 hours or 52mls/hour
  Therefore 239.5mls/hour for the first 4 hours then 52mls/hour
  Decrease to maintenance fluids if no signs of dehydration

This may seem initially like a lot of fluid to give but remember this is a patient who is significantly dehydrated and showing clinical signs.

Ongoing monitoring is key in all these patients.

4. **References**
   - NICE clinical guideline 29; Intravenous fluid therapy in children and young people. Dec 2015
   doi:10.1136/archdischild-2016-310648
Algorithm 1: 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

See table on page 5
For surgical neonates please refer to NSU fluid guideline CG 938 in Medical Handbook

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 131-154mmol/litre with 5-10% glucose

Yes

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

Child or young person

Calculate routine maintenance IV fluid rates for children and young people using the Holiday-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 – 0.9% sodium chloride + 5/10% glucose + 10mmol KCl, Hartmann’s or Plasmalyte with glucose

Risk of SIADH?

No

Consider restricting fluids to 50-80% of routine maintenance needs

Yes

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

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Algorithm 2: Managing hyponatraemia (plasma sodium less than 135 mmol/litre) that develops during IV fluid therapy

Be aware that the following symptoms are associated with acute hyponatraemia:

- Headache
- Nausea and vomiting
- Confusion and disorientation
- Irritability
- Lethargy
- Reduced consciousness
- Convulsions
- Coma
- Apnoea

Hyponatraemia symptoms present?

No

If a child is prescribed a hypotonic fluid, change to an isotonic fluid (for example, 0.9% sodium chloride)

Yes

Seek immediate expert advice (for example, from the paediatric intensive care team)

If hypervolaemic or at risk of hypervolaemia, restrict maintenance IV fluids to 50-80% of routine maintenance needs

Consider a bolus of 2 ml/kg (maximum 100ml) of 2.7% sodium chloride over 10-15 mins

Symptoms still present after the initial bolus?

No

Yes

Consider a further bolus of 2 ml/kg (maximum of 100ml) of 2.7% sodium, chloride over the next

Symptoms still present after the second bolus?

No

Yes

Check plasma sodium level and consider a third bolus of 2ml/kg (maximum of 100 ml of 2.7% sodium chloride over 10-15 mins

Measure plasma sodium concentration at least hourly

As symptoms resolve, decrease the frequency of plasma sodium measurements based on response to treatment

Ensure that the rate of increase of plasma sodium does not exceed 12 mmol/litre per 24 hours (0.5mmol/litre per hour)
Algorithm 3: Managing hypernatraemia (plasma sodium more than 145 mmol/litre) that develops during IV fluid therapy

If hypernatraemia develops, review the fluid status and 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 0.9% sodium chloride

Ensure that rate of fall of plasma sodium does not exceed 12 mmol/litre in a 24-hour period (0.5mmol/litre/hour)

Hypernatraemia worsening or unresponsive?

No

Measure plasma electrolyte concentrations every 4-8 hours for the first 24 hours, and after this base the frequency of further plasma electrolyte measurements on the treatment response.