1. Introduction and who this guideline applies to

This guideline is for medical and nursing staff working within UHL Children’s Hospital caring for patients requiring fluid and electrolyte management.

Exclusions

- Condition-specific fluid and electrolyte management including but not limited to:
  - Diabetic ketoacidosis; metabolic conditions; trauma; burns; tumour-lysis syndrome; hyper-hydration regimes; acute kidney injury (stage 2 onwards)
- Patients admitted under surgical specialties
- Patients prescribed total parenteral nutrition (TPN)
- Children in whom a specialist has recommend a specific fluid and electrolyte management plan (e.g. patients under gastroenterology /renal medicine / metabolic medicine)
- Neonates before the initial postnatal diuresis or weight loss

Related Documents

- Acute Kidney Injury AKI UHL Childrens Hospital Guideline - UHL C86/2016
- Diabetes (Including Diabetic Ketoacidosis) UHL Childrens Hospital Guideline - UHL C10/2019
- Gastroenteritis UHL Childrens Hospital Guideline - UHL C37/2006
• Guideline for Management of Fluids in Children and Young People with known Renal Disorders Fluid management in renal disorders Nottingham University Hospitals NHS Trust
• Sickle Cell Disease - Management UHL Childrens Medical Guideline UHL C17/2016
• Metabolic Conditions UHL Childrens Medical Guideline UHL C97/2016
• Pyloric Stenosis UHL Childrens Hospital Guideline UHL C159/2016
• Infant Feeding Policy UHL LLR and Childrens Centre Services UHL E1/2015
• UHL Parenteral Nutrition guidelines UHL C42/2018, C43/2018, C44/2018, C45/2018

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Background

This guideline is based on current NICE guidance and it provides a framework for prescribing fluids safely in paediatrics. Fluid prescriptions require careful consideration to provide optimum therapeutic benefits and prevent electrolyte abnormalities. Clinicians must consider the indication for fluid management, choice of fluid, choice of route, calculate a target volume and set the correct delivery rate to prescribe fluids safely.

Broadly speaking there are three main aims of fluid management:

1. Resuscitation - fluids are given for rapid volume expansion in the critically unwell patient.
2. Maintenance plus correction for dehydration - fluids are usually combined with maintenance fluids for patients with detectable dehydration and ongoing losses. Careful consideration needs to be given to the type of fluid being lost to account for differences in electrolyte content (see appendix 7.1).
3. Maintenance - fluids for patients who are refusing feeds, establishing feeds or are nil by mouth awaiting a procedure or sedation.

Unfortunately complications are rife and can be precipitated by poor prescribing and infrequent patient review. We emphasise that enteral rehydration is safer than intravenous fluid (IV), so clinicians should aim to withdraw IV fluids at the earliest opportunity. We also recommend frequent patient review to prevent complications.
2. Clinical assessment

The aim of clinical assessment is to identify patients requiring fluid management and assign a level of clinical risk to guide fluid prescription.

Our guideline identifies three groups: firstly those in clinical hypovolaemic shock; secondly those who have clinically detectable dehydration (but crucially are not in hypovolaemic shock); and thirdly those who examine normally but are at risk of dehydration.

Clinicians categorise the degree of dehydration based on a thorough history, clinical examination and biochemistry. A weight on admission and a weight trend is often useful for assessing dehydration with 1 Kg equivalent to 1 Litre of fluid. A focused history should identify risk factors for dehydration, co-morbidities and medications that may affect fluid status such as diuretics or laxatives. Patient examination should be centred on determining fluid status.

Figure 1 is a decision-aid to guide patient assessment to stratify their level of dehydration.
Identifying patients who may need fluid management
Enteric losses (diarrhoea and/ or vomiting), renal losses, hypovolaemia, electrolyte imbalances, food refusal, patient is nil by mouth

Clinical Assessment
Physical examination, observations, weight trend, urine output, urea and electrolytes, blood gas, medications review

Categorise severity based on assessment

Shock (figure 2)
Physical examination – decreased level of consciousness, pale or mottled skin, cold extremities

Observations-
Tachypnoea, tachycardia, weak peripheral pulses, prolonged capillary refill time, hypotension

Biochemistry-
Metabolic acidosis, increased lactate, raised base excess, raised urea and creatinine

Dehydration (figure 3)
Physical examination – Altered responsiveness (irritable/ lethargic), sunken eyes, dry mucous membranes, skin colour unchanged, warm extremities, reduced skin turgor

Observations-
Tachypnoea, tachycardia, normal pulses, normal capillary refill time, normal BP

At risk of dehydration (figure 4)
Physical examination – Alert, eyes not sunken, moist mucous membranes, skin colour unchanged, warm extremities, normal skin turgor

Observations-
Normal heart rate, normal resp rate, tachycardia, normal pulses, normal capillary refill time, normal BP

Figure 1 – Clinical assessment and categorisation of dehydration
Fluid resuscitation in hypovolaemic shock

10ml/kg or 20ml/kg IV bolus of either
0.9% Sodium Chloride or ‘Plasmalyte 148’*

10ml/kg bolus
For patients who are at risk of fluid overload e.g. pre-existing cardiac / renal conditions, neonates

20ml/kg bolus
For patients without co-morbidities and who are > 28 days old (corrected for gestation)

Reassess – does my patient need another bolus?

YES
Repeat bolus if patient is still in clinical shock, reassess after each bolus
(Up to a total 60 ml/kg in non-HDU settings)

NO
After 40 ml/kg

Discuss all patients who have received >40 ml/kg resuscitation fluids with the intensive care team

Give full maintenance IV fluids and consider 10% correction over 48 hours
(Take FBC, U+E, blood gas and glucose before starting)
- Use 0.9% Sodium Chloride with 5% dextrose or ‘Plasmalyte 148 with 5% glucose’
- Consider adding potassium
(See figure 5 and appendix 7.2)

Figure 2– Initial fluid resuscitation hypovolaemic shock
*Plasmalyte only available on CICU
**Management of clinically detectable dehydration (without shock)**

**Enteral rehydration – NGT or PO**

1. Give oral or NG rehydration solutions (e.g. dioralyte):
   a. In under 5 years-old - volume to be given over 4 hours is 50 ml/kg in addition to their usual 4-hourly maintenance requirement. (See figure 7 for calculations)
   b. Consider pump feeds via NGT if bolus feeds are not tolerated
   c. Oral fluids should continue to be offered little and often
2. Consider using a child’s usual fluids (e.g. breastmilk, breastfeeding or formula) if oral rehydration solutions are refused orally
3. Discourage fruit juices, low-sugar squash and fizzy drinks

---

**Does my patient need IV fluid?**

E.g. Unable to keep up with losses, signs of shock appearing

- **YES**
  - **Patient deteriorating**
  - Consider managing as clinical shock (figure 2)

- **YES**
  - **Remains dehydrated despite initial management**
  - Give full maintenance IV fluids with 5% correction over 24 hours (figures 6 and 7)

- **NO**
  - **Patient improving**
  - Consider patient as rehydrated and manage as ‘at risk of dehydration’ (figure 4)

---

**Figure 3– Management of dehydration**
Patient is at risk of dehydration (but no clinically detectable dehydration)

Is my patient nil by mouth?

YES

Give IV fluids at full maintenance rate (See figure 6 for fluid choice, see figure 7 for fluid calculations)

NO

Are there risk factors for severe dehydration?
Less than 1 year old, low birth weight infants, more than 2 vomits or more than 5 loose stools in 24 hours

YES

Give 5ml/kg oral rehydration solution after each large watery stool/vomit in addition to encouraging usual feeds

NO

Encourage usual oral fluids
1. Breastfeeds, milk feeds, water
2. Offer oral fluids little and often

Is intake sufficient and sustainable?

NO

Consider escalating management as per ‘dehydration’ if signs of dehydration appear (figure 3)

YES

Continue current management and normalise to demand feeds where possible

Figure 4– Management of patients at risk of dehydration but not clinically dehydrated
<table>
<thead>
<tr>
<th>ENTERAL FLUID (NGT or PO) – fluid choice and rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fluid type</strong></td>
</tr>
<tr>
<td>Dehydrated</td>
</tr>
<tr>
<td>- Use rehydration solutions such as dioralyte</td>
</tr>
<tr>
<td>- Use usual feeds/fluids if oral rehydration solution is refused and child does not appear unwell</td>
</tr>
<tr>
<td>- Discourage fizzy drinks or pure fruit juices</td>
</tr>
<tr>
<td>At risk of dehydration</td>
</tr>
<tr>
<td>- Offer usual feeds, water, milk feeds (breast or other milk-containing feeds)</td>
</tr>
<tr>
<td>- Give little and often</td>
</tr>
<tr>
<td>- Offer 5mls/kg after each loose stool or vomit</td>
</tr>
</tbody>
</table>

If at particular risk of dehydration e.g. infants less than 1 year old, low birth weight infants, more than 2 vomits or 5 loose stools in 24 hours –

Figure 5 – Summary chart on enteral fluid choices and rates
### IV FLUID – fluid choice and rate

<table>
<thead>
<tr>
<th></th>
<th>Fluid type</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical shock</strong></td>
<td>Use glucose-free crystalloid that contains sodium (131-154 mmol/litre) e.g.</td>
<td>Neonate or pre-existing condition that makes this patient at risk of</td>
</tr>
<tr>
<td>(bolus)</td>
<td>‘Plasmalyte 148’ or 0.9% Sodium Chloride</td>
<td>fluid overload</td>
</tr>
<tr>
<td></td>
<td><em>Do not ADD potassium to any fluids used for bolus</em></td>
<td>No co-morbidities and &gt;28 days old</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 10 ml/kg over less than 10 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 20 ml/kg over less than 10 minutes</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td>0.9% Sodium Chloride + 5% dextrose or ‘Plasmalyte 148 + 5% dextrose’</td>
<td>Full maintenance plus 10% correction over 48 hours</td>
</tr>
<tr>
<td>after correction of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>clinical shock</td>
<td>Glucose-containing crystalloid that contains sodium (131-154 mmol/litre)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(For neonates consider 10% dextrose plus bespoke additives—see neonatal guidelines)</td>
<td></td>
</tr>
<tr>
<td><strong>Dehydrated</strong></td>
<td>• See maintenance after correction of clinical shock</td>
<td>Full maintenance plus 5% correction over 24 hours</td>
</tr>
<tr>
<td><strong>At risk of</strong></td>
<td>• See maintenance after correction of clinical shock</td>
<td>Full maintenance over 24 hours</td>
</tr>
<tr>
<td>dehydration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If there is no evidence of hyperkalaemia or renal impairment you should routinely supplement potassium chloride *except in bolus for shock*

- Give 20mmol per 500ml bag in potassium depletion
- Give 10mmol per 500ml bag for maintenance

**‘Plasmalyte 148’ contains 5mmol/L of Potassium; you *cannot* add anything to these bags. If your patient requires more than this, use either 0.9% Sodium Chloride (with or without dextrose) and add Potassium as shown above**

*Figure 6 – Summary chart on IV fluid choices and rates*
Calculating daily maintenance requirements in children

As per the Holliday-Segar formula:

100 ml/kg for the first 10 Kg
50 ml/kg for the next 10 Kg
20 ml/kg for any weight after 20 Kg

This will give you full daily maintenance volume; divide by 2 to get half maintenance

Divide by 24 to get an hourly rate for your fluid prescription

Worked example - 22 Kg patient

Full maintenance volume = 1540ml [(100ml x10) + (50ml x10) + (20 ml x2)]
Full maintenance hourly rate = 64 ml/hour

Half maintenance volume = 770ml [½ (100ml x10) + (50ml x10) + (20 ml x2)]
Half maintenance hourly rate = 32 ml/hour

Calculating daily maintenance requirements in neonates

Day 1 - 60 ml/kg/day
Day 2 - 90 ml/kg/day
Day 3 - 120 ml/kg/day

Day 4-28 -
120 ml/kg/day for IV
150 ml/kg/day for enteral
Calculating correction volumes in children

*Remember – these volumes are in ADDITION to daily full maintenance*

5% Dehydration volume = 50 ml for every Kg
10% Dehydration volume = 100 ml for every Kg

These volumes are then added to full maintenance to give full maintenance + % correction.

**Worked example 1- 22 Kg patient with 5% dehydration (to be given over 24 hours)**

- 5% Dehydration volume = 1100ml (5 x 10 ml x 22 kg)
- 5% Dehydration hourly rate over 24 hours = 46 ml/hour

- Full maintenance volume = 1540ml [(100ml x 10) + (50ml x 10) + (20 ml x 2)]
- Full maintenance hourly rate = 64 ml/hour

- Therefore, full maintenance plus 5% correction (to be given over 24 hours) is:

5% Dehydration volume = 1100ml (5 x 10 ml x 22 Kg) **PLUS**
Full maintenance volume = 1540ml [(100ml x 10) + (50ml x 10) + (20 ml x 2)]
= 2650 ml (to be given over 24 hours)

- 5% Dehydration (over 24 hours) hourly rate = 46 ml/hour **PLUS**
Full maintenance hourly rate = 64 ml/hour
= 110 ml/hour (for 24 hours)

**Worked example 2- 22 Kg patient with 10% dehydration (to be given over 48 hours)**

- 10% Dehydration volume = 2200ml (10 x 10 ml x 22 kg)
- 10% Dehydration (over 48 hours) hourly rate = 46 ml/hour

- Full maintenance volume = 1540ml [(100ml x 10) + (50ml x 10) + (20 ml x 2)]
- Full maintenance hourly rate = 64 ml/hour

- Therefore, full maintenance plus 5% correction (to be given over 48 hours) is:

10% Dehydration volume = 2200ml (10 x 10 ml x 22 Kg) **PLUS**
Full maintenance volume for the first 24 hours = 1540ml [(100ml x 10) + (50ml x 10) + (20 ml x 2)]
**PLUS**
Full maintenance volume for the second 24 hours = 1540ml [(100ml x 10) + (50ml x 10) + (20 ml x 2)]
= 5280 ml (to be given over 48 hours)

- 10% Dehydration (over 48 hours) hourly rate = 46 ml/hour **PLUS**
Full maintenance hourly rate = 64 ml/hour
= 110 ml/hour (for 48 hours)
2.1 Management of hypovolaemic shock

Clinical shock from hypovolaemia is a medical emergency requiring immediate fluid resuscitation. Figure 2 is based on the APLS algorithm for managing hypovolaemic shock. Patients may require repeat fluid boluses until they are no longer in clinical shock. If a patient has received more than 40 ml/kg of resuscitation fluids we recommend urgent discussion with PICU for ongoing management.

2.2 Management of dehydration

Patients who are not in shock but have clinical signs of dehydration need careful and frequent assessment of their hydration status. If oral fluids are not tolerated, pass a nasogastric tube (NGT) to give fluids. If despite this enteral fluids are still not tolerated, IV fluids should be prescribed as maintenance with 5% correction.

Figure 3 gives guidance on how to manage patients who are dehydrated but not in clinical shock.

Figures 5, 6 and 7 will help with fluid choice, rate of delivery and fluid calculations respectively.

Management of patients at risk of dehydration

Patients who have no clinical signs of dehydration but their history or clinical presentation suggests they might become dehydrated can be managed as per the algorithm in figure 3. If a patient is to remain nil by mouth for a prolonged period such as for a procedure or pre-sedation, prescribe full maintenance IV fluids that contain glucose and potassium.

If a patient is unable to tolerate fluids orally, for example, secondary to a painful mouth or increased work of breathing, consider a nasogastric tube for fluids.

Figures 5, 6 and 7 will help with fluid choice, rate of delivery and fluid calculations respectively.

Choosing a fluid type and rate

Choosing the correct fluid for the correct indication can prevent electrolyte abnormalities. We advocate early introduction of potassium supplementation, unless there are specific contraindications.

Appendices 7.2 and 7.3 show the constituents of prescribed fluids in comparison to plasma.

Fluid rate is variable depending on the clinical scenario. Figures 5+6 summarises the rate of fluid delivery depending on the indication.

Fluid calculations

Fluid requirements in children are calculated based on weight and we seldom prescribe more than 2500ml per day for routine maintenance.
When calculating percentage correction for dehydration, remember that this represents a daily volume that should be ADDED to the daily maintenance volume. It is often helpful to consider the hourly rates for maintenance and for correction as separate; you can then add these to give the rate to be delivered (maintenance + correction). There are worked examples in figure 7.

2.3 Monitoring and ongoing assessment

Indication and requirements

Every child on IV fluids should have their requirement for fluids reviewed twice daily:
- Consider introduction of enteral fluids at the earliest possible opportunity
- The child’s fluid requirements should be calculated and recorded on a daily basis.

Fluid balance

Every child on fluid management requires an accurate fluid balance chart documenting:
- All input (including medications)
- All output including on-going losses and urine output
- Sub-total should be recorded every 4 hours and 12 hours
- Total balance recorded over 24 hours

Review fluid balance charts with every fluid prescription.

Biochemistry

Prior to starting IV fluids, patients should have:
- Blood gas
- Glucose
- Urea and creatinine
- Serum electrolytes (sodium, potassium, chloride)
- FBC

Every 24 hours (or sooner if indicated) we suggest:
- Urea and creatinine
- Serum electrolytes (sodium, potassium, chloride)
- Glucose – daily or sooner if indicated

Every 24 hours (or sooner if indicated) we consider:
- FBC
- Urinary electrolytes

Physical examination

- Clinical assessment of fluid status
- Observations trend, blood pressure and heart rate
- Actual or estimated daily body weight
- Record the weight from the current day, the previous day, and the difference between the two. If an estimate was used, the actual weight should be measured as soon as clinically possible.
Electrolyte imbalances

Electrolyte imbalances are commonly encountered in fluid management and the most likely affected are sodium and potassium. As a general rule, electrolyte abnormalities should be corrected slowly to prevent sudden shifts in fluid through concomitant changes in the osmotic gradient. The best cited example is osmotic cerebral demyelination in sudden changes in sodium levels. As such, sodium levels should be corrected no quicker than 0.5 mmol/l per hour (up to a maximum of 12 mmol/l in 24 hours).

Here we discuss how to troubleshoot anomalies in potassium and sodium levels in relation to IV fluid management. However please note that these topics are covered in the context of IV fluid prescribing only and the guidance here is not a comprehensive guide in managing all causes of sodium or potassium imbalances.

2.4 Hyponatremia in IV fluid management

A sodium level of less than 135 mmol/l defines hyponatremia. Either sodium <125 mmol/l or <135 mmol/l with symptoms defines severe hyponatremia. This is rare and patients may exhibit headaches, nausea/vomiting, altered responsiveness, hyporeflexia and seizures. Severe hyponatremia is a medical emergency that requires a bolus of 2 ml/kg (maximum 100 ml per bolus) of 2.7% sodium chloride to prevent neurological deterioration. These patients are usually managed in the intensive care setting.

In non-severe hyponatremia, clinicians must assess the sodium level in-accordance to fluid status.

Figure 8 is a decision-aid for guiding management of fluids in hyponatremia.
**Symptomatic or Na⁺< 125?**

- Altered responsiveness/confusion, hyporeflexia, seizures, headache, Irritability

---

**Likely volume overloaded**
- Restrict fluids to half maintenance
- Consider diuretics
- (Caution in nephrotic syndrome, renal failure, cardiac disease)
- Review sodium every 4-6 hours*

**Consider underlying cause**
- Is this SIADH? (E.g. sepsis, pneumonia, head injury)
- Is the patient on diuretics?
- Consider fluid restriction to 2/3 maintenance (if not on diuretics)
- Review sodium every 4-6 hours*

**Likely dehydration**
- Categorise into clinical shock, dehydrated or at risk of dehydration (as per figure 1)
- Review sodium every 4-6 hours*

---

**Assess fluid status**

- **Hypervolaemic**
- **Hypovolaemic**
- **Euvolaemic**

---

**Consider emergency management on HDU/CICU**

- Give IV bolus of NaCl 2.7%-2ml/kg (maximum 100ml per bolus)
- Neuro observations
- Manage seizures as per APLS

---

*DO NOT CORRECT SODIUM QUICKER THAN 12 MMOL IN 24 HOURS*

**Figure 8– Management of hyponatraemia during IV fluid management**


**NB:** Paper copies of this document may not be the most recent version. The definitive version is held in the Trust Policy and Library.
**Likely dehydration**

1. Consider adding IV correction volumes over 48 hours.
2. Do not use fluid bags without sodium
3. Do not use fluid bags with reduced sodium e.g. 0.45% NaCl + 5% dextrose
4. Review sodium levels every 4-6 hourly*

**Likely iatrogenic**

1. Consider withdrawal of IV fluids if patient is volume replete
2. If IV fluids are still indicated, consider 0.45% NaCl with 5% dextrose at the current rate. Use cautiously and ensure sodium levels are checked every 4 hours to avoid sudden drops in sodium levels*

*DO NOT CORRECT SODIUM QUICKER THAN 12 MMOL IN 24 HOURS

*Figure 9– Management of hypernatraemia during IV fluid management*
Management of hyperkalaemia

Severe $K^+ > 6.9$

1. Stop all potassium containing fluids (enteral or IV)
2. Stop medications that increase potassium levels
3. Treat underlying cause
4. Review diet
5. Early nephrology review if renal pathology suspected

Are there ECG changes? (See appendix 7.3)

CALL CICU
Stabilise cardiac membrane
IV Calcium gluconate 10%
0.5ml / kg (max 20ml)
Given over 5-10 minutes.

YES

Salbutamol
2.5 or 5mg nebulised
Repeat as necessary

NO

On CICU or HDU consider:
1. IV sodium bicarbonate correction if acidotic
2. IV furosemide (1mg/kg)
3. IV insulin/glucose infusion

Recheck $K^+$ every 30 mins

Mild/moderate $K^+ 5.9 - 6.9$

1. Obtain free-flowing venous sample
2. Clinical correlation – could this be pseudo hyperkalaemia (see appendix 7.4)?

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IV Calcium gluconate 10%
0.5ml / kg (max 20ml)
Given over 5-10 minutes.

YES

Salbutamol
2.5 or 5mg nebulised
Repeat as necessary

NO

On CICU or HDU consider:
1. IV sodium bicarbonate correction if acidotic
2. IV furosemide (1mg/kg)
3. IV insulin/glucose infusion

Recheck $K^+$ every 30 mins

Mild/moderate $K^+ 5.9 - 6.9$

1. Obtain free-flowing venous sample
2. Clinical correlation – could this be pseudo hyperkalaemia (see appendix 7.4)?

CALL CICU
Stabilise cardiac membrane
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Recheck $K^+$ every 30 mins

Mild/moderate $K^+ 5.9 - 6.9$

1. Obtain free-flowing venous sample
2. Clinical correlation – could this be pseudo hyperkalaemia (see appendix 7.4)?
Management of hypokalaemia

Mild, moderate or severe?

Severe K⁺ < 2.5
Obtain ECG

Symptomatic or ECG changes?
(See appendix 7.5)

YES

Call CICU
Patient may need emergency central access to give higher concentrations of potassium than is safe to give peripherally.

NO

Give IV fluids with potassium
Available as KCL 20mmol or 10mmol in 500ml with 0.9% NaCl + 5% dextrose
Aim to give 1 mmol/kg (max 20 mmol)
(Maximum infusion concentration

Give enteral potassium chloride
(0.5 - 1 mmol/kg BD)
Available as Kay-Cee-L (1 mmol/ml)
Available as Sando-K (12 mmol/tablet)
Monitor U+E daily and adjust dose

Mild
K⁺ 3.1 – 3.5

Yes

NO

Is my patient nil by mouth?

NO

Figure 11–
Management of hypokalaemia during IV fluid management

Mild, moderate or severe?

Moderate K⁺ 2.5–3
Obtain ECG

YES

Give IV fluids with potassium
Available as KCL 20mmol or 10mmol in 500ml with 0.9% NaCl + 5% dextrose
Aim to give 1 mmol/kg (max 20 mmol)
(Maximum infusion concentration

Give enteral potassium chloride
(0.5 - 1 mmol/kg BD)
Available as Kay-Cee-L (1 mmol/ml)
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Monitor U+E daily and adjust dose

Severe K⁺ < 2.5
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Symptomatic or ECG changes?
(See appendix 7.5)

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Available as Kay-Cee-L (1 mmol/ml)
Available as Sando-K (12 mmol/tablet)
Monitor U+E daily and adjust dose

Mild
K⁺ 3.1 – 3.5

Yes

NO

Is my patient nil by mouth?

NO

Figure 11–
Management of hypokalaemia during IV fluid management
2.5 Hypernatraemia in IV fluid management

A sodium level of more than 145 mmol/l defines hypernatremia. The principal causes for this is are either dehydration or sodium (and fluid) overload from IV fluids. To differentiate, one must interpret the raised sodium level with the patient’s fluid status.

A dehydrated patient with hypernatraemia is likely to have a normal total body sodium level but a raised intravascular sodium level due to haemoconcentration. In these patients, you must not reduce the level of sodium delivery in their fluid prescription but instead focus on providing increased fluid volumes to correct the sodium and dehydration simultaneously. Consider full maintenance with correction volumes over 48 hours to reduce the risk of sudden shifts in sodium levels.

A hypervolaemic or euvolaemic patient with hypernatraemia is likely to be sodium overloaded through IV fluid prescribing. Remember that water follows sodium via osmosis so these patients are likely to be volume overloaded too. Withdraw IV fluids where possible in these situations to prevent further supra-physiological delivery of sodium. If IV fluids cannot be stopped, consider prescribing 0.45% Sodium Chloride with 5% dextrose. This must however be used with great caution to prevent any sudden shifts in sodium and therefore osmolality. Remember that sodium levels should be corrected no quicker than 0.5 mmol/l per hour (up to a maximum of 12 mmol/l in 24 hours).

Figure 9 is a decision-aid for guiding management of fluids in hypernatraemia.

2.6 Hyperkalaemia in IV fluid management

Hyperkalaemia can be a life threatening medical emergency that can potentially induce cardiac arrhythmia. There are many causes of apparent hyperkalaemia but true hyperkalaemia is rare. However high potassium levels should always prompt urgent clinical review and consideration of cardiac monitoring and stabilisation. Our local network hospital for nephrology has a comprehensive guideline on the management of hyperkalaemia. A copy is available on Nottingham Childrens' Hospitals website entitled Management of hyperkalaemia (see figure 10 and Section 5)

Appendices 7.3 and 7.4 show ECG changes in hyperkalaemia and causes of pseudo hyperkalaemia respectively.

2.7 Hypokalaemia in IV fluid management

A potassium level of less than 3.5 mmol/l defines hypokalaemia. This is usually caused by gastric losses, reduced dietary intake, medications (such as salbutamol or insulin) or from intracellular shifts secondary to refeeding. Symptoms include muscular dysfunction such as cramping, gastric ileus, fasciculation and in severe cases cardiac arrhythmias.

Figure 11 is a decision-aid for guiding management of fluids in hypokalaemia.

Appendices 7.5 show ECG changes in hypokalaemia.
### 3. Education and Training

Junior doctors local induction

Prescribing intravenous fluids online module provided by e-learning for health. Available at [https://portal.e-lfh.org.uk/Component/Details/443277](https://portal.e-lfh.org.uk/Component/Details/443277)

### 4. Monitoring Compliance

<table>
<thead>
<tr>
<th>What will be measured to monitor compliance</th>
<th>How will compliance be monitored</th>
<th>Monitoring Lead</th>
<th>Frequency</th>
<th>Reporting arrangements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients who are prescribed fluids have a documented fluid status including mention of any red flags if present</td>
<td>Audit</td>
<td>Ruth Radcliffe</td>
<td>3-Yearly</td>
<td></td>
</tr>
<tr>
<td>Patients prescribed IV fluids have a documented weight or estimated weight</td>
<td>Audit</td>
<td>Ruth Radcliffe</td>
<td>3-Yearly</td>
<td></td>
</tr>
<tr>
<td>Patients prescribed IV fluids have a correct calculated delivery rate and volume</td>
<td>Audit</td>
<td>Ruth Radcliffe</td>
<td>3-Yearly</td>
<td></td>
</tr>
<tr>
<td>Patients given resuscitation fluids receive either 0.9% Sodium Chloride or 'Plasmalyte 148'</td>
<td>Audit</td>
<td>Ruth Radcliffe</td>
<td>3-Yearly</td>
<td></td>
</tr>
<tr>
<td>Patients who are prescribed IV fluids have had a baseline FBC, U+E, blood gas</td>
<td>Audit</td>
<td>Ruth Radcliffe</td>
<td>3-Yearly</td>
<td></td>
</tr>
<tr>
<td>Patients who are prescribed IV fluids have an accurate fluid balance chart with 4,12 and 24-hourly totals</td>
<td>Audit</td>
<td>Ruth Radcliffe</td>
<td>3-Yearly</td>
<td></td>
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<tr>
<td>Patients who are prescribed IV fluids should have daily (or sooner) FBC, U+E and glucose</td>
<td>Audit</td>
<td>Ruth Radcliffe</td>
<td>3-Yearly</td>
<td></td>
</tr>
<tr>
<td>Patients who are prescribed IV fluids should have a documented consideration for enteral fluids/withdrawal of IV fluids</td>
<td>Audit</td>
<td>Ruth Radcliffe</td>
<td>3-Yearly</td>
<td></td>
</tr>
</tbody>
</table>

### 5. Supporting Documents and Key References

Diarrhoea and vomiting caused by gastroenteritis in under 5s: diagnosis and management. NICE CG84 2009


Torres SF, Lolster T, Schnitzler EJ, Serrate AJS, Sticco NA, Rivarola MR. Hypotonic and isotonic intravenous maintenance fluids in hospitalised paediatric patients: a randomised controlled trial. British Journal of Medicine Paediatrics Open. 2019; 3 (1)

Allen CH et al. A randomised trial of plasma Lyte A and 0.9% sodium chloride in acute paediatric gastroenteritis. BMC paediatrics. 2016; 16 (117)


6. Key Words

Fluid, Electrolytes, Intravenous fluid, Enteral, Dehydration, hyperkalaemia, hypernatraemia, hypokalaemia, hyponatraemia

The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs. As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.
<table>
<thead>
<tr>
<th>CONTACT AND REVIEW DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Guideline Lead (Name and Title)</strong></td>
</tr>
<tr>
<td>Ruth Radcliffe</td>
</tr>
</tbody>
</table>

**Details of Changes made during review:**

- Extensive formatting and re-configuration throughout
- Added - Use of plasmalyte
- Amended - changes to neonates maintenance fluid volume – changed from

**Maintenance Fluid Volume: Neonates**

<table>
<thead>
<tr>
<th>Day</th>
<th>Fluid Volume (ml/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>4-28</td>
<td>120</td>
</tr>
</tbody>
</table>

**To**

<table>
<thead>
<tr>
<th>Day</th>
<th>Fluid Volume (ml/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>2-</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>120</td>
</tr>
<tr>
<td>4-28</td>
<td>120 for IV, 150 for enteral</td>
</tr>
</tbody>
</table>

7. Appendices

7.1. NICE guidelines diagram of ongoing losses in paediatric patients

- **Vomiting and nasogastric tube loss**
  - Gastric fluid contains:
    - 20–60 mmol Na⁺/l
    - 14 mmol K⁺/l
    - 140 mmol Cl⁻/l
    - 60–80 mmol H⁺/l.
  - Excessive loss causes a hypochloremic (hypokalaemic), metabolic alkalosis. Correction requires supplemental K⁺ and Cl⁻.

- **‘Pure’ water loss (e.g. fever, dehydration, hyperventilation)**
  - Mainly insensible water loss (i.e. relatively low electrolyte content); results in potential hypernatraemia.

- **Biliary drainage loss**
  - 145 mmol Na⁺/l
  - 5 mmol K⁺/l
  - 105 mmol Cl⁻/l
  - 30 mmol HCO₃⁻/l

- **Pancreatic drain or fistula**
  - 125–138 mmol Na⁺/l
  - 8 mmol K⁺/l
  - 56 mmol Cl⁻/l
  - 85 mmol HCO₃⁻/l

- **Diarrhoea or excess colostomy loss**
  - 30–140 mmol Na⁺/l
  - 30–70 mmol K⁺/l
  - 20–80 mmol HCO₃⁻/l

- **Jejunal loss via stoma or fistula**
  - 140 mmol Na⁺/l
  - 5 mmol K⁺/l
  - 135 mmol Cl⁻/l
  - 8 mmol HCO₃⁻/l

- **High volume ileal loss via new stoma, high stoma or fistula**
  - 100–140 mmol Na⁺/l
  - 4–5 mmol K⁺/l
  - 75–125 mmol Cl⁻/l
  - 0–30 mmol HCO₃⁻/l

- **Lower volume ileal loss via established stoma or low fistula**
  - 50–100 mmol Na⁺/l
  - 4–5 mmol K⁺/l
  - 25–75 mmol Cl⁻/l
  - 0–30 mmol HCO₃⁻/l

- **Inappropriate urinary loss**
  - (e.g. polyuria)
  - Na⁺/l and K⁺/l very variable, so monitor serum electrolytes closely.

- **Ongoing blood loss**
  - (e.g. melena)
### 7.2. Composition of IV fluids mentioned in this guideline

<table>
<thead>
<tr>
<th></th>
<th>Na⁺ (mmol/l)</th>
<th>K⁺ (mmol/l)</th>
<th>Cl⁻ (mmol/l)</th>
<th>HCO₃⁻ (mmol/l)</th>
<th>Glucose</th>
<th>Ca²⁺ (mmol/l)</th>
<th>Mg²⁺ (mmol/l)</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal Plasma</strong></td>
<td>135-145</td>
<td>3.5 - 5</td>
<td>100-110</td>
<td>22-26</td>
<td>N/A</td>
<td>2.2 to 2.6</td>
<td>0.8 - 1</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Glucose-free crystalloid that contains sodium (131-154 mmol/l)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.9% Sodium Chloride</td>
<td>154</td>
<td>0 (can add 20 or 40)</td>
<td>154</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Plasmalyte 148</strong></td>
<td>140</td>
<td>5</td>
<td>98</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>Gluconate 23mmol/l</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Acetate 27mmol/l</td>
</tr>
<tr>
<td><strong>Glucose-containing crystalloid that contains sodium (131-154 mmol/l)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.9% Sodium Chloride + 5% dextrose</td>
<td>154</td>
<td>0 (can add 20 or 40)</td>
<td>154</td>
<td>0</td>
<td>50g per litre</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Plasmalyte 148 + 5% dextrose</strong></td>
<td>140</td>
<td>5</td>
<td>98</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>Gluconate 23mmol/l</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Acetate 27mmol/l</td>
</tr>
<tr>
<td><strong>Glucose-containing crystalloid that contains reduced sodium</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.45% Sodium Chloride + 5% dextrose</td>
<td>77</td>
<td>0 (can add 20 or 40)</td>
<td>77</td>
<td>0</td>
<td>50g per litre</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

### 7.3. Composition of dioralyte

<table>
<thead>
<tr>
<th></th>
<th>Na⁺ (mmol/l)</th>
<th>K⁺ (mmol/l)</th>
<th>Cl⁻ (mmol/l)</th>
<th>HCO₃⁻ (mmol/l)</th>
<th>Glucose</th>
<th>Ca²⁺</th>
<th>Mg²⁺</th>
<th>Citrate (mmol/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal Plasma</strong></td>
<td>135-145</td>
<td>3.5 - 5</td>
<td>100-110</td>
<td>22-26</td>
<td>N/A</td>
<td>2.2</td>
<td>2.6</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Dioralyte</strong></td>
<td>60</td>
<td>20</td>
<td>50</td>
<td>0</td>
<td>3.56g per 200 ml sachet</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>
7.4 ECG changes in hyperkalaemia (image from www.ecgwaves.com)

- Tall peaked t-waves
- QRS widens
- Wide-complex tachycardia (severe hyperkalaemia)
- Sine wave formation (severe hyperkalaemia)

7.5. Causes of pseudo hyperkalaemia

- Sampling error:
  - Haemolysed blood sample
  - Squeezed heel / toe/ finger pricks
  - Prolonged tourniquet time
  - A non free-flowing sample
  - EDTA contamination (FBC bottle was taken before U+E bottle)
  - Sampling downstream from a drip-arm or line containing potassium
  - Sampling from a line where TPN, blood or IV fluids containing potassium were given
- Extreme leucocytosis
- Hereditary spherocytosis
- Familial pseudo hyperkalaemia
- Hyperventilation e.g. due to crying (acute respiratory alkalosis may cause potassium to shift out of cells)

7.6. ECG changes in hypokalaemia ([www.my-ekg.com](http://www.my-ekg.com))

**Moderate Hypokalemia:**
ST depression, T waves flattening (red arrows), prominent U waves (orange arrows).

**Severe Hypokalemia:**
ST depression, negative T waves (red arrows), prominent U waves (orange arrows).

- ST depression
- Negative T-waves (flattened at first)
- Prominent U-waves