Intravenous fluid therapy in children and young people in hospital

NICE guideline: short version

Draft for consultation, May 2015

If you wish to comment on this version of the guideline, please be aware that all the supporting information and evidence is contained in the full version.

Contents

Introduction

This guideline contains recommendations about general principles for managing intravenous (IV) fluids in children and young people under 16 years, and applies to a range of conditions and different settings. It does not include recommendations relating to specific conditions.

Correct fluid and electrolyte balance is essential to maintain physiological function. Normally, children and young people get the fluid they need by drinking. Many children and young people admitted to hospital may be too ill to drink so may need intravenous (IV) fluid therapy to correct or maintain their fluid and electrolyte balance.

Children and young people may need IV fluids to account for losses of red blood cells, plasma, water or electrolytes beyond the usual losses in urine, stools and sweat. These losses can come from burns, diarrhoea, vomiting or leakage of fluid into the interstitial space. In these cases the aim is to replace any depleted fluids and restore electrolyte balance. Conditions such as cardiac dysfunction, liver disease, inappropriate antidiuretic hormone secretion and nephrotic syndrome can result in an excess of fluids in the body, known as fluid overload. If this happens, the aim is to rebalance and redistribute fluids and ensure the correct levels of electrolytes.

Whether IV fluid therapy is needed for fluid resuscitation, routine maintenance, replacement or redistribution, it is vital that the correct composition, volume and timing of IV fluid therapy is used. IV fluid types include colloids, crystalloids and combinations of fluids, and different types of fluids are appropriate for different situations. Errors in prescribing or administering IV fluids can result in inadequate or excessive provision, leading to hypovolaemia and poor organ perfusion, or hypervolaemia, oedema and heart failure. Failing to correct imbalances in electrolytes can lead to disturbances in intracellular or extracellular electrolyte balance, particularly in children and young people with reduced liver or kidney function. Failing to

deliver correct fluids can therefore have a significant impact on morbidity and mortality.

Surveys have shown that many staff who prescribe IV fluids know neither the likely fluid and electrolyte needs of individual patients, nor the specific composition of the many choices of IV fluids available to them.There is little formal training and education in IV fluid management to support correct prescribing.

There is also a wide variation in the charts used to prescribe fluids and to record fluid and electrolyte status. Monitoring children and young people is often challenging: it may be difficult to assess urine output accurately, and blood tests can be painful, distressing and difficult to repeat. Assessment and monitoring is often suboptimal, and fluid and electrolyte status may not be recorded accurately. Changes in patients' fluid needs may not be reassessed appropriately or at the correct intervals, which can lead to fluids being prescribed incorrectly. Clinical staff need to ensure that appropriate identification, treatment and monitoring of changes in fluid and electrolyte status is maintained and documented. There is a need for a standardised approach to assessing patients' fluid and electrolyte status and prescribing IV fluid therapy in the NHS. This guidance represents a major opportunity to improve patient safety for children and young people having IV fluid therapy in hospital.

Safeguarding children

Remember that child maltreatment:

- is common
- can present anywhere, such as emergency departments and primary care or on home visits.

Be aware of or suspect abuse as a contributory factor to or cause of the symptoms or signs of dehydration in children. Abuse may also coexist with dehydration. See the NICE guideline on child maltreatment for clinical features that may be associated with maltreatment.

Medicines

The guideline will assume that prescribers will use a medicine's summary of product characteristics to inform decisions made with individual patients.

This guideline recommends some medicines for indications for which they do not have a UK marketing authorisation at the date of publication, if there is good evidence to support that use. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. The patient (or those with authority to give consent on their behalf) should provide informed consent, which should be documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information. Where recommendations have been made for the use of medicines outside their licensed indications ('off-label use'), these medicines are marked with a footnote in the recommendations.

Patient-centred care

This guideline offers best practice advice on the care of children and young people who need intravenous (IV) fluids.

Patients and healthcare professionals have rights and responsibilities as set out in the NHS Constitution for England – all NICE guidance is written to reflect these. Treatment and care should take into account individual needs and preferences. Patients should have the opportunity to make informed decisions about their care and treatment, in partnership with their healthcare professionals. If the patient is under 16, their family or carers should also be given information and support to help the child or young person to make decisions about their treatment. If it is clear that the child or young person fully understands the treatment and does not want their family or carers to be involved, they can give their own consent. Healthcare professionals should follow the Department of Health's advice on consent. If someone does not have capacity to make decisions, healthcare professionals should follow the code of practice that accompanies the Mental Capacity Act and the supplementary code of practice on deprivation of liberty safeguards.

If a young person is moving between paediatric and adult services, care should be planned and managed according to the best practice guidance described in the Department of Health's Transition: getting it right for young people.

Adult and paediatric healthcare teams should work jointly to provide assessment and services to young people who need IV fluids. Diagnosis and management should be reviewed throughout the transition process, and there should be clarity about who is the lead clinician to ensure continuity of care.

Strength of recommendations

Some recommendations can be made with more certainty than others. The Guideline Development Group makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the Guideline Development Group is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

For all recommendations, NICE expects that there is discussion with the patient about the risks and benefits of the interventions, and their values and preferences. This discussion aims to help them to reach a fully informed decision (see also 'Patient-centred care').

Interventions that must (or must not) be used

We usually use 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally we use 'must' (or 'must not') if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

Interventions that should (or should not) be used – a 'strong' recommendation

We use 'offer' (and similar words such as 'refer' or 'advise') when we are confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost effective. We use similar forms of words (for example, 'Do not offer…') when we are confident that an intervention will not be of benefit for most patients.

Interventions that could be used

We use 'consider' when we are confident that an intervention will do more good than harm for most patients, and be cost effective, but other options may be similarly cost effective. The choice of intervention, and whether or not to

have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

Key priorities for implementation

The following recommendations have been identified as priorities for implementation. The full list of recommendations is in section 1 [hyperlink to be added for final publication].

Assessment and monitoring

- In neonates, children and young people who are receiving IV fluids, assess and document the following on the fluid balance and prescription chart:
  - Actual or estimated body weight from the previous day, the current day and the difference between the 2, or body surface area if used (see recommendation 1.2.2).
  - Fluid input, output and balance over the previous 24 hours.
  - Any special instructions for prescribing, including relevant history.
  - An assessment of the fluid status.
  - The results of laboratory and point-of-care assessments, including:
    - ◊ full blood count
    - ◊ urea
    - ◊ creatinine
    - ◊ plasma electrolyte concentrations (including chloride, sodium and potassium; see recommendation 1.2.4)
    - ◊ blood glucose (see recommendation 1.2.5)
    - ◊ urinary electrolyte concentrations.
  - Details of any ongoing losses (see recommendation 1.5.1 and the diagram of ongoing losses).
  - Calculations of fluid needs for routine maintenance, replacement, redistribution and resuscitation.
  - The fluid and electrolyte prescription (in ml per hour), with clear signatures, dates and times.
  - Fluid limits.
  - Types and volumes of fluid input and output (urine, gastric and other), recorded hourly and with running totals.

- 12-hourly fluid balance subtotals.
- 24-hourly fluid balance totals.
- 12-hourly reassessments of:
  - the fluid prescription
  - current hydration status
  - whether oral fluids can be started
  - potassium requirements
  - urine and other outputs. **[1.2.3]**

Fluid resuscitation

- If children and young people need IV fluid resuscitation, use glucose-free crystalloids[1] that contain sodium in the range 130–154 mmol/litre, with a bolus of 20 ml/kg over less than 10 minutes. **[1.3.1]**
- If neonates need IV fluid resuscitation, use glucose-free crystalloids[1] that contain sodium in the range 130-154 mmol/litre, with a bolus of 10-20 ml/kg over less than 10 minutes. **[1.3.2]**

Routine maintenance

- If children and young people need IV fluids for routine maintenance, initially use isotonic crystalloids[2] that contain sodium in the range 130–154 mmol/litre. **[1.4.3]**
- Measure plasma electrolyte concentrations and blood glucose when starting IV fluids for routine maintenance (except before most elective surgery), and at least every 24 hours thereafter. **[1.4.4]**
- If neonates need IV fluids for routine maintenance, initially use isotonic crystalloids[2] that contain sodium in the range 130–154 mmol/litre with 5–10% glucose. **[1.4.7]**

[1] At the time of consultation (May 2015), some glucose-free crystalloids did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

[2] At the time of consultation (May 2015), some isotonic crystalloids with 5–10% glucose did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

- If there is a risk of water retention associated with non-osmotic antidiuretic hormone (ADH) secretion, consider restricting fluids to 50–80% of the routine maintenance needs. **[1.4.9]**

Replacement and redistribution

- Use a 0.9% sodium chloride solution for initial fluid replacement and redistribution. **[1.5.2]**

Managing hyponatraemia that develops during intravenous fluid therapy

- If asymptomatic hyponatraemia develops in neonates, children and young people, review the fluid status and take action as follows:
  - If a child is prescribed a hypotonic fluid, change to an isotonic fluid (for example, 0.9% sodium chloride).
  - Restrict maintenance IV fluids in children and young people who are hypervolaemic or at risk of hypervolaemia (for example, if there is a risk of increased ADH secretion). **[1.7.1]**
- Be aware that the following symptoms are associated with acute hyponatraemia during IV fluid therapy:
  - Headache.
  - Nausea and vomiting.
  - Confusion and disorientation.
  - Irritability.
  - Lethargy.
  - Reduced consciousness.
  - Convulsions.
  - Coma.
  - Apnoea. **[1.7.2]**

1 Recommendations

The following guidance is based on the best available evidence. The full guideline [hyperlink to be added for final publication] gives details of the methods and the evidence used to develop the guidance.

Terms used in this guideline

Neonates, children and young people are defined as follows:

- neonates: infants aged 28 days and under (born at term)
- children: 29 days to under 12 years
- young people: 12 to under 16 years.

Expert: In this guideline, the term 'expert' refers to a healthcare professional who has core competencies to diagnose and manage acute illness. These competencies can be delivered by a variety of models at a local level, such as a critical care outreach team, a hospital-at-night team or a specialist trainee in an acute medical or surgical specialty.

1.1 Principles and protocols for intravenous fluid therapy

1.1.1 For guidance on the principles and protocols for intravenous (IV) fluid therapy, see section 1.1 in the NICE guideline on intravenous fluid therapy in adults (recommendations 1.1.1–1.1.3 and 1.1.5–1.1.8 apply to all ages).

1.1.2 Offer IV fluid therapy as part of a protocol (see Algorithms for IV fluid therapy in children and young people in hospital):

- Assess fluid and electrolyte needs following Algorithm 1: Assessment and monitoring.
- If neonates, children and young people need IV fluids for fluid resuscitation, follow Algorithm 2: Fluid resuscitation.
- If neonates, children and young people need IV fluids for routine maintenance, follow Algorithm 3: Routine maintenance.

- If neonates, children and young people need IV fluids to address existing deficits or excesses, ongoing abnormal losses or abnormal fluid distribution, follow Algorithm 4: Replacement and redistribution.
- If hypernatraemia develops, follow Algorithm 5: Managing hypernatraemia that develops during IV fluid therapy.
- If hyponatraemia develops, follow Algorithm 6: Managing hyponatraemia that develops during IV fluid therapy.

1.2 Assessment and monitoring

1.2.1 Use body weight to calculate IV fluid and electrolyte needs for neonates, children and young people.

1.2.2 Consider using body surface area to calculate IV fluid and electrolyte needs if accurate calculation of insensible losses is important (for example, if the weight is above the 91st centile, or with acute kidney injury or cancer).

1.2.3 In neonates, children and young people who are receiving IV fluids, assess and document the following on the fluid balance and prescription chart:

- Actual or estimated body weight from the previous day, the current day and the difference between the 2, or body surface area if used (see recommendation 1.2.2).
- Fluid input, output and balance over the previous 24 hours.
- Any special instructions for prescribing, including relevant history.
- An assessment of the fluid status.
- The results of laboratory and point-of-care assessments, including:
  - full blood count
  - urea
  - creatinine

  - plasma electrolyte concentrations (including chloride, sodium and potassium; see recommendation 1.2.4)
  - blood glucose (see recommendation 1.2.5)
  - urinary electrolyte concentrations.
- Details of any ongoing losses (see recommendation 1.5.1 and the diagram of ongoing losses).
- Calculations of fluid needs for routine maintenance, replacement, redistribution and resuscitation.
- The fluid and electrolyte prescription (in ml per hour), with clear signatures, dates and times.
- Fluid limits.
- Types and volumes of fluid input and output (urine, gastric and other), recorded hourly and with running totals.
- 12-hourly fluid balance subtotals.
- 24-hourly fluid balance totals.
- 12-hourly reassessments of:
  - the fluid prescription
  - current hydration status
  - whether oral fluids can be started
  - potassium requirements
  - urine and other outputs.

1.2.4 Measure plasma electrolyte concentrations using laboratory tests at least every 24 hours, and more frequently if there are electrolyte disturbances.

1.2.5 Measure blood glucose at least every 24 hours, and more frequently if there is a risk of hypoglycaemia.

1.2.6 Consider point-of-care testing for measuring plasma electrolyte concentrations and blood glucose in time-critical situations when IV fluids are needed (for example during emergency situations and in A&E, theatre and critical care).

1.2.7 Diagnose clinical dehydration and hypovolaemic shock using the clinical features listed in table 1, but be aware that it can be difficult to identify the clinical features in neonates.

Table 1: Clinical features of dehydration and hypovolaemic shock

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

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, one 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 section 1.2 in the NICE guideline on diarrhoea and vomiting in children.

1.3 Fluid resuscitation

1.3.1 If children and young people need IV fluid resuscitation, use glucose-free crystalloids[3] that contain sodium in the range 130–154 mmol/litre, with a bolus of 20 ml/kg over less than 10 minutes.

1.3.2 If neonates need IV fluid resuscitation, use glucose-free crystalloids[3] that contain sodium in the range 130–154 mmol/litre, with a bolus of 10–20 ml/kg over less than 10 minutes.

1.3.3 For neonates, children and young people who have hypovolaemic shock due to blood loss and need IV fluid resuscitation, use glucose-free crystalloids[3] that contain sodium in the range 130–154 mmol/litre, with a bolus of 10 ml/kg over less than 10 minutes.

1.3.4 For guidance on using IV fluids for fluid resuscitation in children and young people with diabetic ketoacidosis, see the NICE guideline on diabetes in children [hyperlink to be added at publication][4].

1.3.5 Reassess neonates, children and young people after completion of the IV fluid bolus, and decide whether further fluids are needed.

1.3.6 Seek expert advice if 40–60 ml/kg of IV fluid is needed as part of the initial fluid resuscitation.

1.4 Routine maintenance

1.4.1 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 next 10 kg and 20 ml/kg/day for any remaining weight).

[3] At the time of consultation (May 2015), some glucose free-crystalloids did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

[4] NICE is developing guidance on major trauma, which will include the use of IV fluids for fluid resuscitation. Publication is expected in 2016.

1.4.2 Calculate routine maintenance IV fluid rates for neonates according to their age, 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.
- Days 5–28: 120–150 ml/kg/day.

1.4.3 If children and young people need IV fluids for routine maintenance, initially use isotonic crystalloids[5] that contain sodium in the range 130–154 mmol/litre.

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

1.4.5 Be aware that plasma electrolyte concentrations and blood glucose are not routinely measured before elective surgery unless there is a need to do so, based on the child's medical condition or the type of surgery.

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

1.4.7 If neonates need IV fluids for routine maintenance, initially use isotonic crystalloids[5] that contain sodium in the range 130–154 mmol/litre with 5–10% glucose.

1.4.8 For neonates in critical postnatal adaptation phase (for example, neonates with respiratory distress syndrome, meconium aspiration,

[5] At the time of consultation (May 2015), some isotonic crystalloids with 5–10% glucose did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

hypoxic ischaemic encephalopathy), give no or minimal sodium until postnatal diuresis with weight loss occurs.

1.4.9 If there is a risk of water retention associated with non-osmotic antidiuretic hormone (ADH) secretion, consider restricting fluids to 50–80% of the routine maintenance needs.

1.4.10 When using body surface area to calculate IV fluid needs for routine maintenance (see recommendation 1.2.2), estimate insensible losses within the range 300–400 ml/m^2/24 hours and add to urinary output.

1.5 Replacement and redistribution

1.5.1 If neonates, children and young people need IV fluids for replacement or redistribution, adjust the IV prescription (add to maintenance needs) to account for existing fluid and/or electrolyte deficits or excesses, ongoing losses (see the diagram of ongoing losses) or abnormal distribution.

1.5.2 Use a 0.9% sodium chloride solution for initial fluid replacement and redistribution.

1.5.3 Consider Hartmann's solution for peri-operative redistribution losses.

1.5.4 Use a 0.9% sodium chloride solution containing potassium to replace ongoing losses (see the diagram of ongoing losses).

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

1.6 Managing hypernatraemia that develops during intravenous fluid therapy

1.6.1 If hypernatraemia develops in neonates, children and young people, review the fluid status and take action as follows:

- If there is no evidence of dehydration and an isotonic fluid is being used, consider changing to a hypotonic fluid (for example, 0.45% sodium chloride with glucose)[6].
- If dehydration is diagnosed, calculate the water deficit and replace it over 48 hours, initially with 0.9% sodium chloride.
- If the fluid status is uncertain, measure urine sodium and osmolality.
- If hypernatraemia worsens or is unchanged after replacing the deficit, review the fluid type and consider changing to a hypotonic solution (for example, 0.45% sodium chloride with glucose).

1.6.2 When correcting hypernatraemia, ensure that the rate of fall of plasma sodium does not exceed 12 mmol/litre in a 24 hour period.

1.6.3 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.

1.7 Managing hyponatraemia that develops during intravenous fluid therapy

1.7.1 If asymptomatic hyponatraemia develops in neonates, children and young people, review the fluid status and take action as follows:

- If a child is prescribed a hypotonic fluid, change to an isotonic fluid (for example, 0.9% sodium chloride).
- Restrict maintenance IV fluids in children and young people who are hypervolaemic or at risk of hypervolaemia (for example, if there is a risk of increased ADH secretion).

[6] At the time of consultation (May 2015), some hypotonic solutions did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

1.7.2 Be aware that the following symptoms are associated with acute hyponatraemia during IV fluid therapy:

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

1.7.3 If acute symptomatic hyponatraemia develops in neonates, children and young people, review the fluid status, seek immediate expert advice and take action as follows:

- Consider a bolus of 2 ml/kg (maximum 100 ml) of 2.7% saline over 10–15 minutes.
- Consider a further bolus of 2 ml/kg (maximum 100 ml) of 2.7% saline over the next 10–15 minutes if symptoms are still present after the initial bolus.
- If symptoms are still present after the second bolus, check the plasma sodium level and consider a third bolus of 2 ml/kg (maximum 100 ml) of 2.7% saline over 10–15 minutes.
- Measure the plasma sodium concentration at least hourly.
- As symptoms resolve, decrease the frequency of plasma sodium measurements based on the response to treatment.

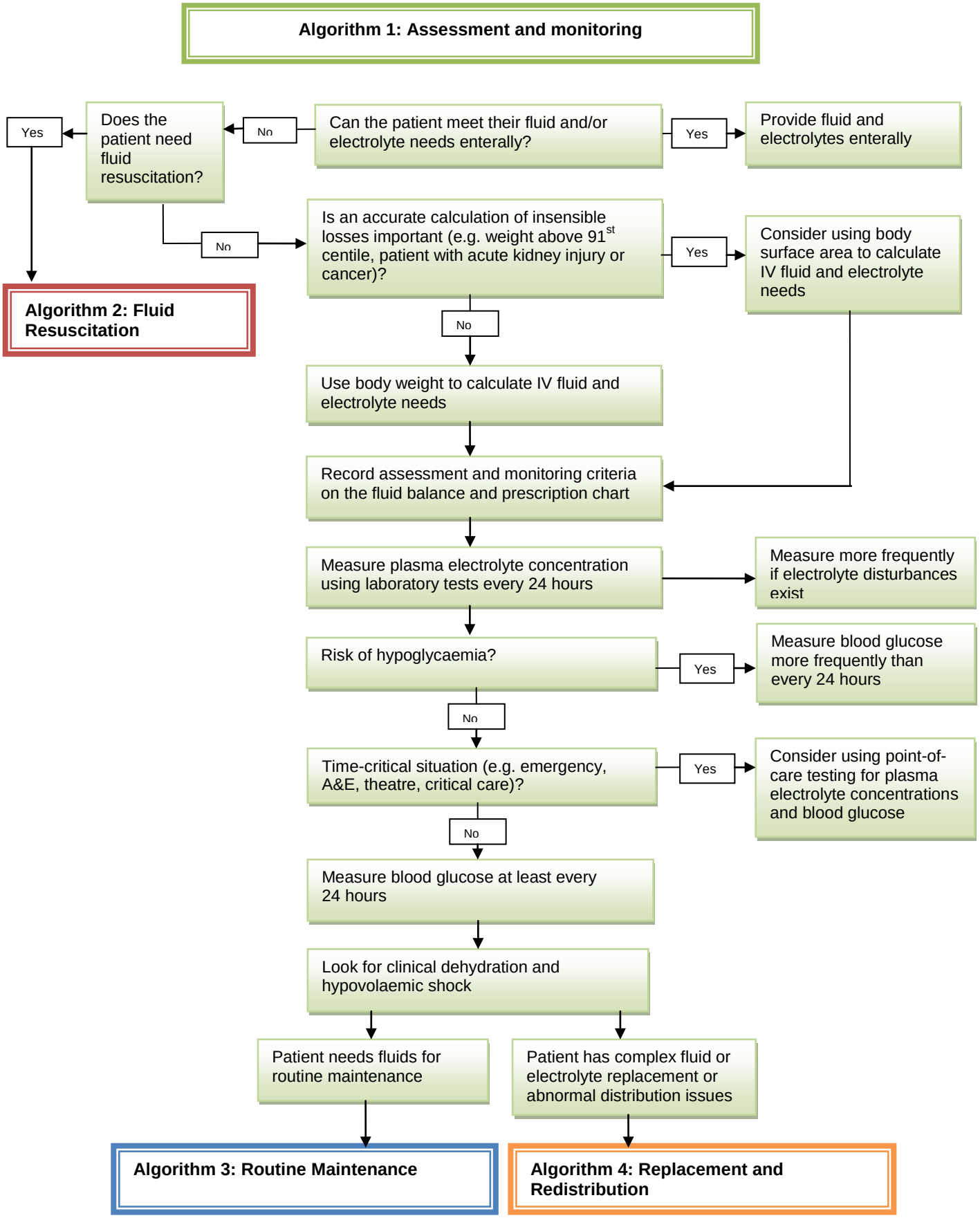
1.7.4 Do not manage acute hyponatraemia encephalopathy using fluid restriction alone.

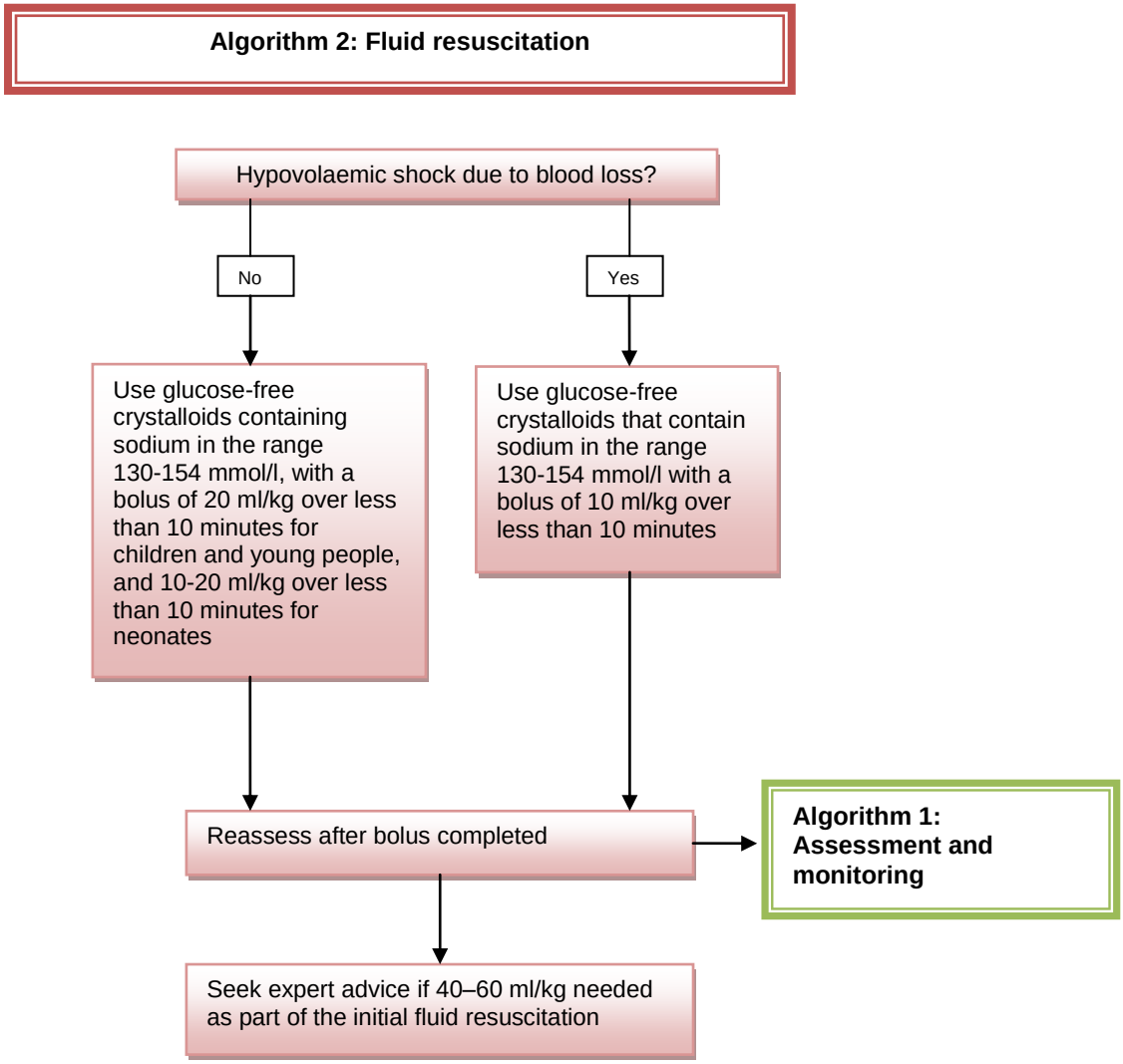
1.7.5 After hyponatraemia symptoms have resolved, ensure that the rate of increase of plasma sodium does not exceed 12 mmol/litre in a 24-hour period.

1.8 Training and education

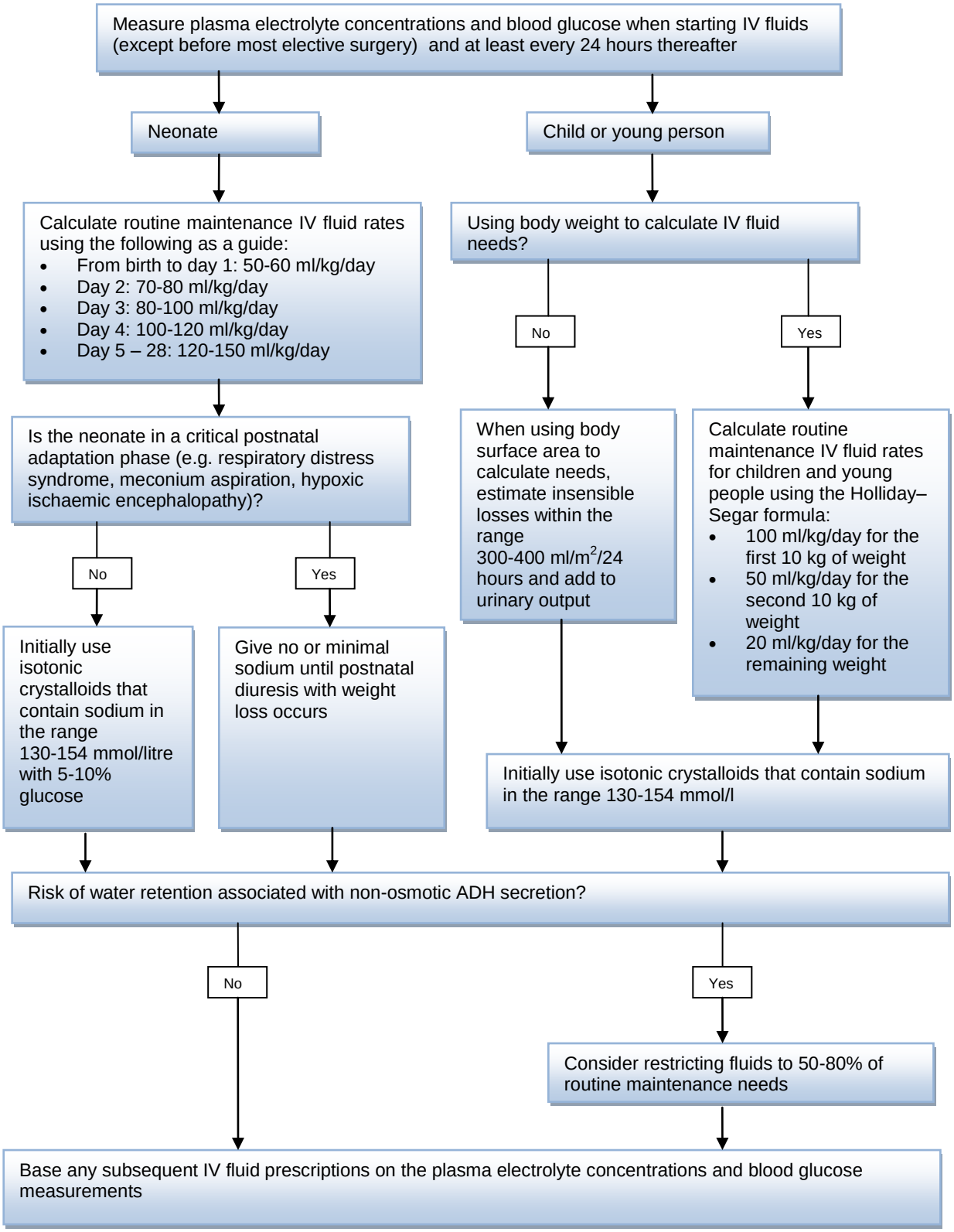
1.8.1 For guidance on training and education for healthcare professionals involved in prescribing and delivering IV fluid therapy, see section 1.6 in the NICE guideline on intravenous fluid therapy in adults.

Algorithms for IV fluid therapy in children and young people in hospital

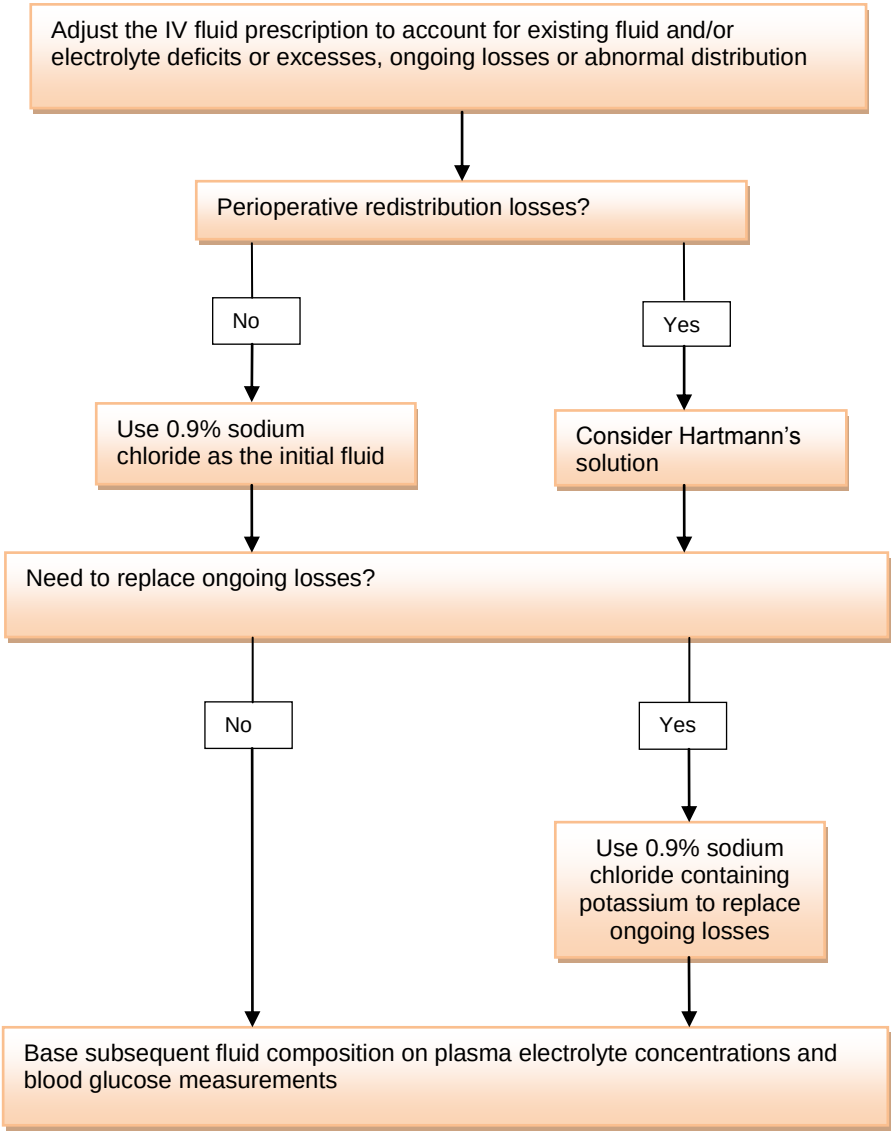



Algorithm 2: Fluid resuscitation
Hypovolaemic shock due to blood loss?
No
Yes
Use glucose-free crystalloids containing sodium in the range 130-154 mmol/l, with a bolus of 20 ml/kg over less than 10 minutes for children and young people, and 10-20 ml/kg over less than 10 minutes for neonates
Use glucose-free crystalloids that contain sodium in the range 130-154 mmol/l with a bolus of 10 ml/kg over less than 10 minutes
Reassess after bolus completed
Algorithm 1: Assessment and monitoring
Seek expert advice if 40–60 ml/kg needed as part of the initial fluid resuscitation

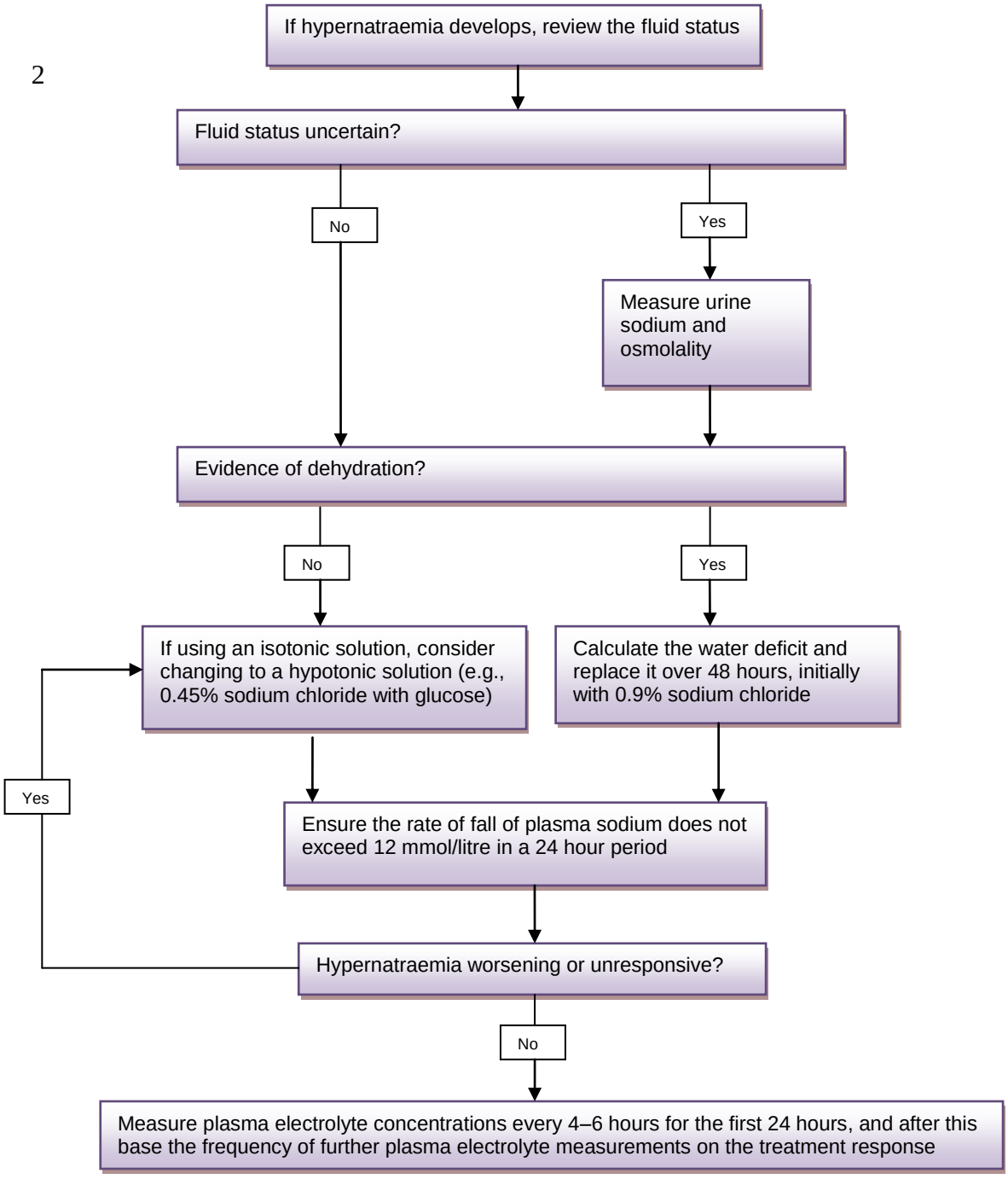
Algorithm 3: Routine Maintenance



Algorithm 4: Replacement and Redistribution



Algorithm 5: Managing hypernatraemia that develops during IV fluid therapy



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Algorithm 6: Managing hyponatraemia 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

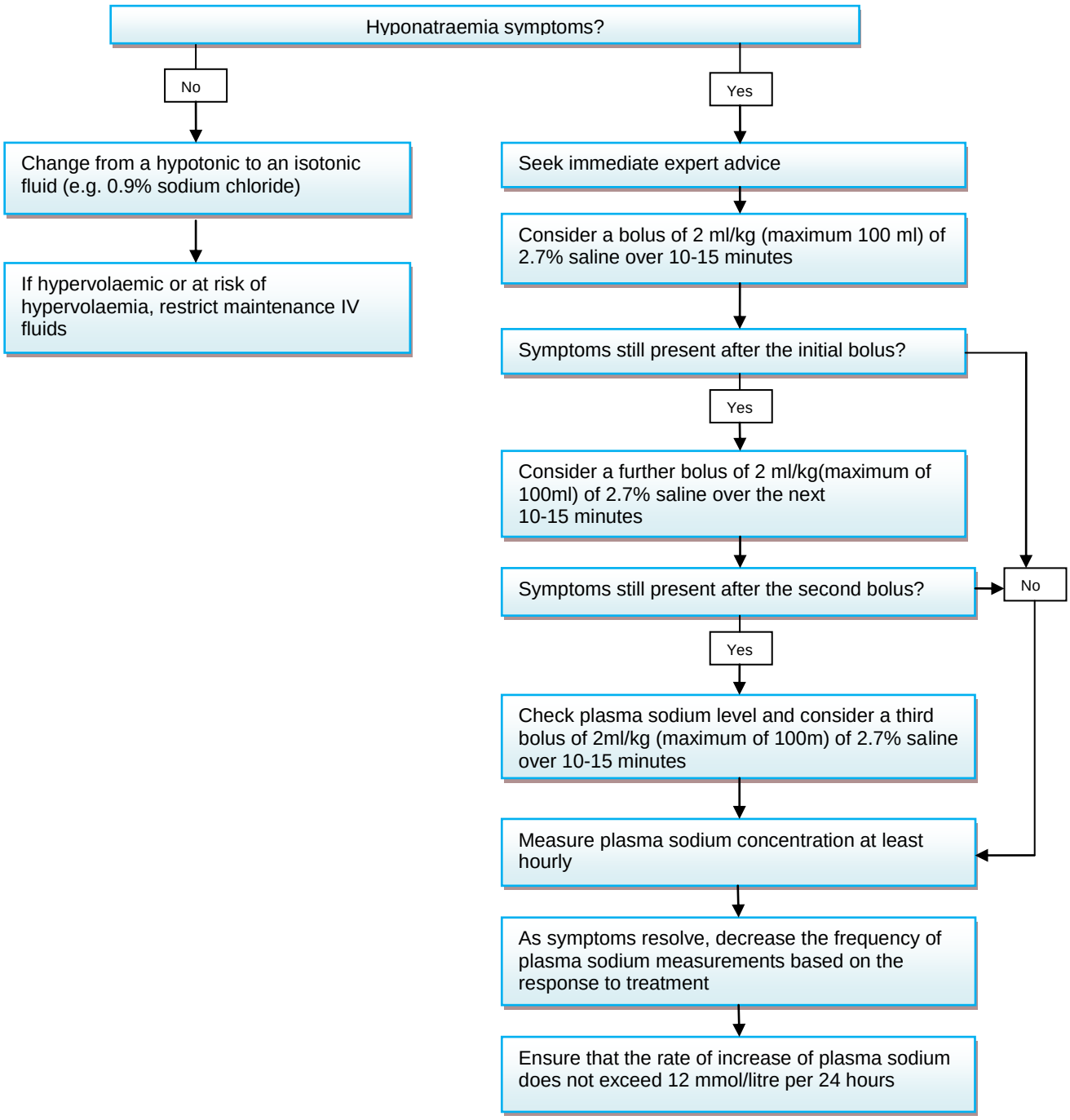
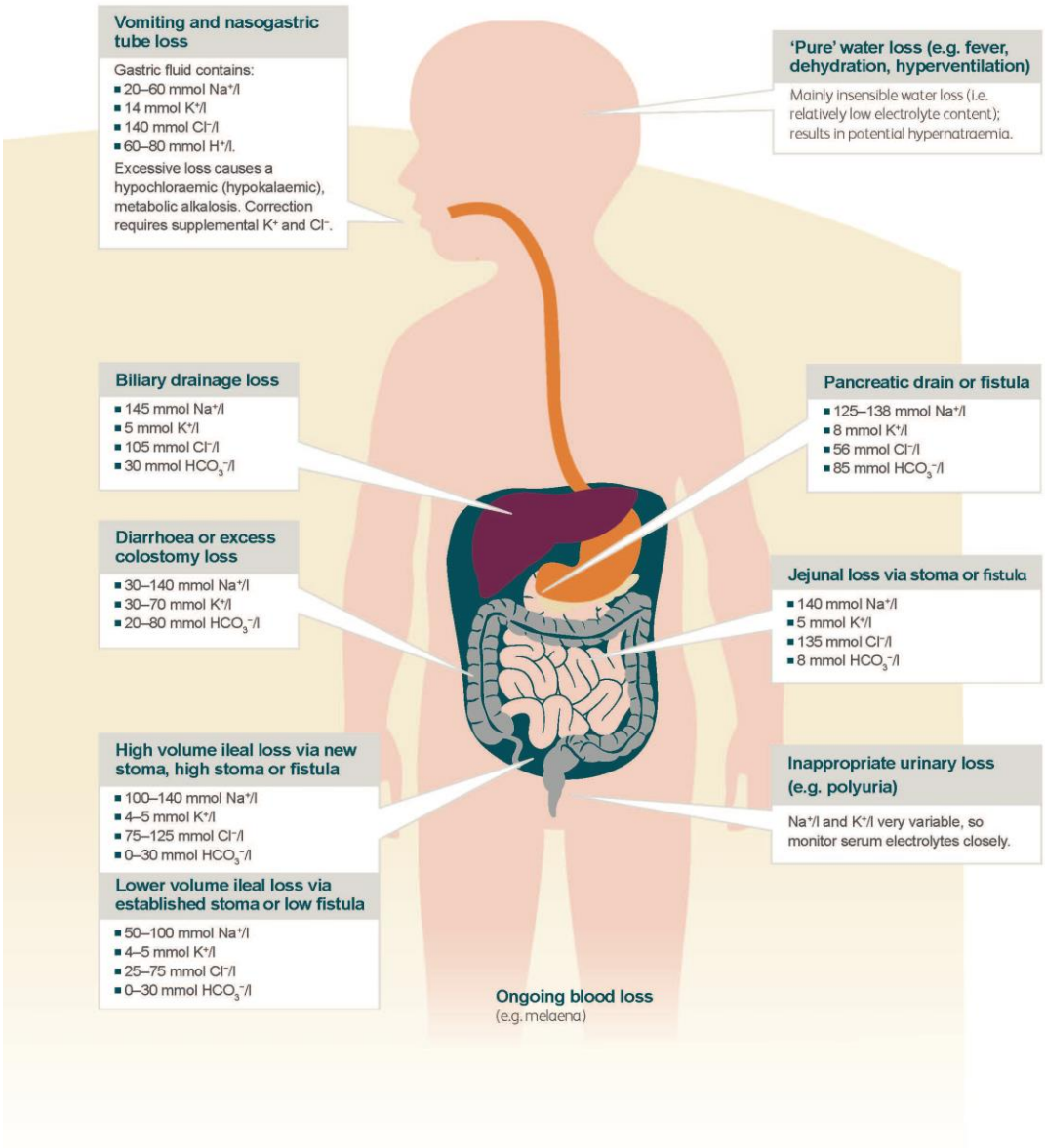


Diagram of ongoing losses

Download the PDF here. [hyperlink to be added for final publication]



Source: Copyright – National Clinical Guideline Centre

2 Research recommendations

The Guideline Development Group has made the following recommendations for research, based on its review of evidence, to improve NICE guidance and patient care in the future. The Guideline Development Group's full set of research recommendations is detailed in the full guideline.[hyperlink to be added for final publication]

2.1 Complications of IV fluid therapy

What is the incidence of complications during, and as a consequence of, IV fluid therapy in children and young people?

Why this is important

Every day, children and young people are prescribed IV fluid therapy for a variety of reasons. However, there is little evidence on IV fluids in children and young people, and the limited evidence available is of very poor quality.

Complications of IV fluid therapy can lead to mortality and significant morbidity for the patient. This, in turn, represents a cost burden for the NHS in terms of critical care admissions, prolonged inpatient stays or the potential need for long-term follow-up and care by medical and allied healthcare professionals.

2.2 Glucose concentration

What is the most appropriate glucose concentration in IV fluids for children and young people of different ages?

Why this is important

In recent years, the use of glucose-containing hypotonic IV fluids in children and young people has been questioned, because of the risk of hyponatraemia. Many children and young people are now prescribed non-glucose-containing isotonic IV fluids for maintenance. However, there are several groups of children and young people, in particular, neonates and some children in the peri-operative period (for example, those who underwent prolonged fasting preoperatively, and those who had central blocks during

anaesthesia), who may benefit from glucose-containing IV solutions to prevent hypoglycaemia. A blanket prescription of 5 or 10% glucose solution for all may result in hyperglycaemia in some children and young people. However, the use of IV fluids containing lower concentrations of glucose may be sufficient to prevent hypoglycaemia and also avoid unnecessary hyperglycaemia. This may have a clinical application across all age groups, including neonates.

2.3 Fluid balance charts

For children and young people receiving IV fluids, does the use of a standardised national fluid balance chart reduce the rate of complications arising as a result of prescription and/or administration errors?

Why this is important

The National Confidential Enquiry into Perioperative Deaths reports in 1999 and 2009 identified problems in fluid management in patients in the UK. A lack of consistency in prescribing and recording IV fluids may contribute to this. A lack of familiarity of 'mobile' medical and nursing staff with fluid balance charts in different hospital settings may further increase the likelihood of prescription and administration errors.

A prospective cohort of children and young people receiving IV fluids, prescribed and documented on a standardised national fluid balance chart, or a case–control study comparing the use of a standardised national fluid balance chart with non-standard 'local' fluid balance charts is needed to assess the clinical and cost effectiveness of using a standardised national fluid balance chart. Outcomes should include complications of IV fluid therapy (hypovolaemia, hypervolaemia, electrolyte abnormalities, neurological complications and hypoglycaemia) and incidence of prescription errors. If using a standardised national fluid balance chart resulted in better fluid prescription and clinical outcomes in children and young people, this would have significant cost implications for the NHS.

2.4 Training and education of healthcare professionals

Does ensuring that all hospital healthcare professionals involved in prescribing and delivering IV fluids for children and young people are

appropriately trained in the principles of fluid prescribing and IV fluid therapy-related complications lead to a reduction in IV fluid-related complications and associated healthcare costs?

Why this is important

Assessing patients' IV fluid needs, as well as prescribing and delivering IV fluids, are essential daily tasks on most paediatric wards. These are complex responsibilities that entail careful clinical and assessment, good understanding of the physiology of fluid homeostasis both in health and disease, and appropriate supervision and training. There is currently no standard training provided for healthcare professionals working in the UK. Any teaching at both undergraduate and postgraduate level is currently delivered *ad hoc*, and in many cases may be limited. If fluid management in hospitalised children and young people is to improve, standardised training is likely to be needed. Any educational interventions made would need to evaluated to assess whether practice had subsequently improved.

3 Other information

3.1 Scope and how this guideline was developed

NICE guidelines are developed in accordance with a scope that defines what the guideline will and will not cover.

How this guideline was developed

NICE commissioned the National Clinical Guideline Centre to develop this guideline. The Centre established a Guideline Development Group (see section 4), which reviewed the evidence and developed the recommendations.

The methods and processes for developing NICE clinical guidelines are described on the NICE website.

3.2 Related NICE guidance

Details are correct at the time of consultation on the guideline (May 2015).

Further information is available on the NICE website.

Published

General

- Medicines adherence (2009) NICE guideline CG76

Condition-specific

- Intravenous fluid therapy in adults in hospital (2013) NICE guideline CG174
- Acute kidney injury (2013) NICE guideline CG169
- Feverish illness in children (2013) NICE guideline CG160
- Neutropenic sepsis (2012) NICE guideline CG151
- Sedation in children and young people (2010) NICE guideline CG112
- Bacterial meningitis and meningococcal septicaemia (2010) NICE guideline CG102
- Diarrhoea and vomiting in children (2009) NICE guideline CG84
- Urinary tract infection in children (2007) NICE guideline CG54
- Pre-hospital initiation of fluid replacement therapy in trauma (2004) NICE technical appraisal guidance TA74

Under development

NICE is developing the following guidance:

- Medicines optimisation. NICE guideline. Publication expected March 2015.
- Bronchiolitis in children. NICE guideline. Publication expected May 2015.
- Diabetes in children and young people. NICE guideline. Publication expected August 2015.
- Transfusion. NICE guideline. Publication expected October 2015.
- Neonatal jaundice. NICE guideline. Publication expected November 2015.
- Major trauma. NICE guideline. Publication expected February 2016.

4 The Guideline Development Group, National Collaborating Centre and NICE project team, and declarations of interests

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4.4 Declarations of interests

The following members of the Guideline Development Group made declarations of interests. All other members of the Group stated that they had no interests to declare.

Member	Interest declared	Type of interest	Decision taken
Peter Crean	Invited to write 2 journal articles on fluid and electrolyte balance in children. One of these is for Anaesthesia and Intensive Care Medicine and the other is for Paediatrics and Child Health. No honorarium received.	Personal non-pecuniary interest	Declare and participate
	Invited to give a talk on IV fluids on 'When things go wrong' at the annual conference of the European Society of Paediatric Anaesthesiology in Prague on 18/9/2014. Travel expenses and hotel accommodation provided as part of the package for all speakers at the conference. No honorarium received.	Personal non-pecuniary interest	Declare and participate
Chris Gildersleve	Received accommodation and travel expenses as an invited speaker at the 2014 APA Annual Scientific Meeting 15-16 May 2014	Personal non-pecuniary interest	Declare and participate
	Invited to speak on IV fluids in children at the Current Concepts meeting at the RCoA, London on 21/11/2014. No honorarium received; travel and accommodation expenses covered.	Personal non-pecuniary interest	Declare and participate
	Invited to speak on IV fluids in children at the Paediatric CPD study day at the RCoA, London on 4/3/2015. No honorarium received; though travel and accommodation expenses covered.	Personal non-pecuniary interest	Declare and participate

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