NICE National Institute for Health and Care Excellence

NICE Pathways

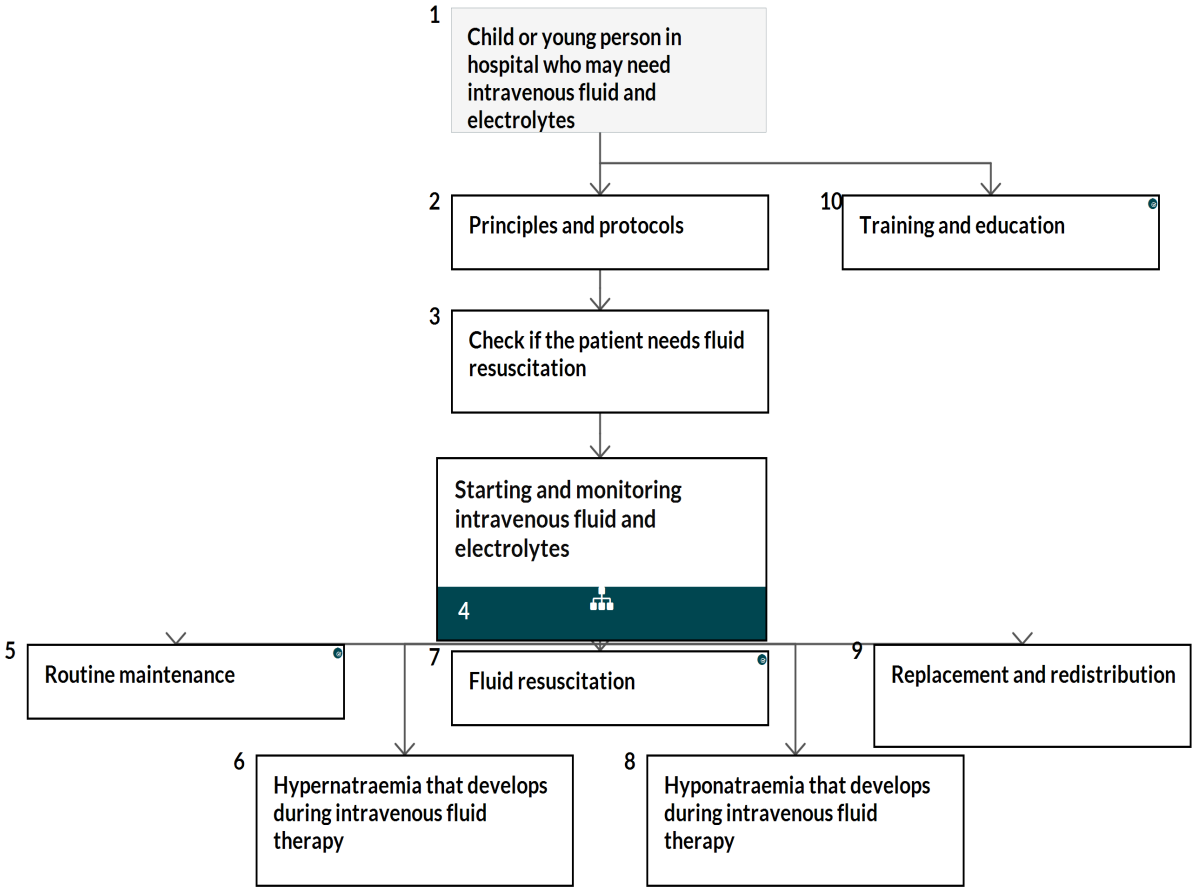
Intravenous fluid therapy in children and young people in hospital

NICE Pathways bring together everything NICE says on a topic in an interactive flowchart. NICE Pathways are interactive and designed to be used online.

They are updated regularly as new NICE guidance is published. To view the latest version of this NICE Pathway see:

http://pathways.nice.org.uk/pathways/intravenous-fluid-therapy-in-hospital
NICE Pathway last updated: 11 June 2020

This document contains a single flowchart and uses numbering to link the boxes to the associated recommendations.



1 Child or young person in hospital who may need intravenous fluid and electrolytes

No additional information

2 Principles and protocols

1.1.1 Assess and manage patients' fluid and electrolyte needs as part of every ward review. Provide IV fluid therapy only for patients whose needs cannot be met by oral or enteral routes, and stop as soon as possible.

1.1.2 Skilled and competent healthcare professionals should prescribe and administer IV fluids, and assess and monitor patients receiving IV fluids (see training and education on intravenous fluid therapy in adults in hospital).

Offer IV fluid therapy as part of a protocol as set out below:

- Assess fluid and electrolyte needs (see calculate intravenous fluid and electrolyte needs and routine maintenance [See page 4]).
- If term neonates, children and young people need IV fluids for fluid resuscitation, see fluid resuscitation [See page 7].
- If term neonates, children and young people need IV fluids for routine maintenance, see routine maintenance [See page 4].
- If term neonates, children and young people need IV fluids to address existing deficits or excesses, ongoing abnormal losses or abnormal fluid distribution, see replacement and redistribution [See page 9].
- If hypernatraemia develops, see hypernatraemia that develops during IV fluid therapy [See page 6].
- If hyponatraemia develops, see hyponatraemia that develops during IV fluid therapy [See page 8].

For further information, see NICE's algorithms for IV fluid therapy in children and young people in hospital.

For information on fluid resuscitation for children and young people with major haemorrhaging due to traumatic injury, see circulatory access and fluid replacement in hospital in the NICE Pathway on trauma.

1.1.5 Include the following information in IV fluid prescriptions:

- The type of fluid to be administered.
- The rate and volume of fluid to be administered.

1.1.6 Patients should have an IV fluid management plan, which should include details of:

- the fluid and electrolyte prescription over the next 24 hours
- the assessment and monitoring plan.

Initially, the IV fluid management plan should be reviewed by an expert daily. IV fluid management plans for patients on longer-term IV fluid therapy whose condition is stable may be reviewed less frequently.

1.1.7 When prescribing IV fluids and electrolytes, take into account all other sources of fluid and electrolyte intake, including any oral or enteral intake, and intake from drugs, IV nutrition, blood and blood products.

1.1.8 Patients have a valuable contribution to make to their fluid balance. If a patient needs IV fluids, explain the decision, and discuss the signs and symptoms they need to look out for if their fluid balance needs adjusting. If possible or when asked, provide written information (for example, NICE's information for the public), and involve the patient's family members or carers (as appropriate).

3 Check if the patient needs fluid resuscitation

Diagnose clinical dehydration and hypovolaemic shock using the clinical features listed in the table on clinical features of dehydration and hypovolaemic shock [See page 11], but be aware that it can be difficult to identify the clinical features in term neonates.

4 Starting and monitoring intravenous fluid and electrolytes

See Intravenous fluid therapy in hospital / Starting and monitoring intravenous fluid and electrolyte needs in children and young people in hospital

5 Routine maintenance

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 the weight over 20 kg). Be aware that over a 24-hour period, males rarely need more than 2,500 ml and females rarely need more than 2,000 ml of fluids.

Calculate routine maintenance IV fluid rates for term 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.

If children and young people need IV fluids for routine maintenance, initially use isotonic crystalloids that contain sodium in the range 131–154 mmol/litre. Note that this is an off-label use for some intravenous fluid therapy preparations in some age groups. See prescribing medicines at NICE website for more information.

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.

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.

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

If term neonates aged 8 days or over need IV fluids for routine maintenance, initially use isotonic crystalloids that contain sodium in the range 131–154 mmol/litre with 5–10% glucose. For term neonates aged up to 7 days, use professional judgement, taking into account:

- the individual circumstances, and
- for term neonates in the first days of life, a sodium content of 131–154 mmol/litre may be too high (or sodium may not be needed) and a glucose content of 5–10% may be too low.

Note that this is an off-label use for some intravenous fluid therapy preparations in some age groups. See prescribing medicines at NICE website for more information.

For term neonates in critical postnatal adaptation phase (for example, term neonates with

respiratory distress syndrome, meconium aspiration, hypoxic ischaemic encephalopathy), give no or minimal sodium until postnatal diuresis with weight loss occurs.

If there is a risk of water retention associated with non-osmotic ADH secretion, consider either:

- restricting fluids to 50–80% of the routine maintenance needs **or**
- reducing fluids, calculated on the basis of insensible losses within the range 300–400 ml/m^2/24 hours plus urinary output.

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

For further information, see NICE's algorithms for IV fluid therapy in children and young people.

Quality standards

The following quality statement is relevant to this part of the interactive flowchart.

Intravenous fluid therapy in children and young people in hospital

4. Fluid type for routine maintenance

6 Hypernatraemia that develops during intravenous fluid therapy

If hypernatraemia develops in term 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). Note that this is an off-label use for some intravenous fluid therapy preparations in some age groups. See prescribing medicines at NICE website for more information.
- 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).

When correcting hypernatraemia, ensure that the rate of fall of plasma sodium does not exceed

12 mmol/litre in a 24-hour period.

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.

For further information, see NICE's algorithms for IV fluid therapy for children and young people.

7 Fluid resuscitation

If children and young people need IV fluid resuscitation, use glucose-free crystalloids that contain sodium in the range 131–154 mmol/litre, with a bolus of 20 ml/kg over less than 10 minutes. Take into account pre-existing conditions (for example, cardiac disease or kidney disease), as smaller fluid volumes may be needed.

Note that this is an off-label use for some intravenous fluid therapy preparations in some age groups. See prescribing medicines at NICE website for more information.

If term neonates need IV fluid resuscitation, use glucose-free crystalloids that contain sodium in the range 131–154 mmol/litre, with a bolus of 10–20 ml/kg over less than 10 minutes.

Note that this is an off-label use for some intravenous fluid therapy preparations in some age groups. See prescribing medicines at NICE website for more information.

Do not use tetrastarch for fluid resuscitation.

For guidance on using IV fluids for fluid resuscitation in children and young people with diabetic ketoacidosis, see fluid and insulin therapy in the NICE Pathway on diabetes in children and young people.

Reassess term neonates, children and young people after completion of the IV fluid bolus, and decide whether they need more fluids.

Seek expert advice (for example, from the paediatric intensive care team) if 40–60 ml/kg of IV fluid or more is needed as part of the initial fluid resuscitation.

For further information, see NICE's algorithms for IV fluid therapy in children and young people.

Quality standards

The following quality statement is relevant to this part of the interactive flowchart.

Intravenous fluid therapy in children and young people in hospital

3. Fluid type for intravenous (IV) fluid resuscitation

8 Hyponatraemia that develops during intravenous fluid therapy

Asymptomatic hyponatraemia

If asymptomatic hyponatraemia develops in term 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) by either:
- restricting maintenance fluids to 50–80% of routine maintenance needs **or**
- reducing fluids, calculated on the basis of insensible losses within the range 300–400 ml/ m^2/24 hours plus urinary output.

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.

Symptomatic hyponatraemia

If acute symptomatic hyponatraemia develops in term neonates, children and young people, review the fluid status, seek immediate expert advice (for example, from the paediatric intensive care team) and take action as follows:

- Use a bolus of 2 ml/kg (maximum 100 ml) of 2.7% sodium chloride over 10–15 minutes.
- Use a further bolus of 2 ml/kg (maximum 100 ml) of 2.7% sodium chloride 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% sodium chloride 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.

Do not manage acute hyponatraemic encephalopathy using fluid restriction alone.

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.

For further information, see NICE's algorithms for IV fluid therapy for children and young people.

9 Replacement and redistribution

If term neonates, children and young people need IV fluids for replacement or redistribution, adjust the IV fluid prescription (in addition 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, for example, tissue oedema seen in sepsis.

Consider isotonic crystalloids that contain sodium in the range 131–154 mmol/litre for redistribution. Note that this is an off-label use for some intravenous fluid therapy preparations in some age groups. See prescribing medicines at NICE website for more information.

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

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

For further information, see NICE's algorithms for IV fluid therapy in children and young people.

10 Training and education

For guidance on training and education for healthcare professionals involved in prescribing and delivering IV fluid therapy, see training and education on intravenous fluid therapy in adults in hospital.

Quality standards

The following quality statement is relevant to this part of the interactive flowchart.

Intravenous fluid therapy in children and young people in hospital

5. Intravenous (IV) fluids lead

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

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 sections on symptoms and signs of clinical dehydration and shock, assessing dehydration and shock and laboratory investigations in the NICE Pathway on diarrhoea and vomiting in children.

Glossary

ADH

antidiuretic hormone

bolus

(a volume of fluid given quickly)

crystalloids

(a solution which is administered intravenously and acts as a volume expander: it is composed of particles which are capable of passing through a semipermeable membrane; examples of crystalloids include 0.9% sodium chloride and Ringer's lactate solution; crystalloids can be divided into the following groups based on their tonicity: isotonic, hypertonic and hypotonic)

dehydration

(depletion of body water and, to varying degrees, electrolytes)

Electrolyte

(ions in solution that acquire the capacity to conduct electricity)

Expert

(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)

fluid resuscitation

(the replacement of bodily fluid lost through pathological processes)

hypernatraemia

(increased sodium level in blood)

hypervolaemia

(term implying that the individual described appears to have increased circulating blood fluid volume within their body)

hyponatraemia

(decreased sodium level in the blood)

hypotonic

(in the context of a human body cell, a hypotonic solution is one with a lower concentration of solutes outside the cell than inside the cell; when a cell is immersed in a hypotonic solution, water will flow into the cell to balance the concentration of solutes)

hypovolaemic shock

(an emergency condition in which severe blood and fluid loss mean that the heart is unable to pump enough blood to the body; this can cause organs to stop working)

isotonic

(in the context of a human body cell, an isotonic solution is one which has the same solute concentration as the cell)

IV

intravenous

neonates

(infants aged 28 days and under (born at term))

oedema

(excessive fluid in or around cells)

Sources

Intravenous fluid therapy in children and young people in hospital (2015 updated 2020) NICE guideline NG29

Intravenous fluid therapy in adults in hospital (2013 updated 2016) NICE guideline CG174

Your responsibility

Guidelines

The recommendations in this guideline represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, professionals and practitioners are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or the people using their service. It is not mandatory to apply the recommendations, and the guideline does not override the responsibility to make decisions appropriate to the circumstances of the individual, in consultation with them and their families and carers or guardian.

Local commissioners and providers of healthcare have a responsibility to enable the guideline to be applied when individual professionals and people using services wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with complying with those duties.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should assess and reduce the environmental impact of implementing NICE recommendations wherever possible.

Technology appraisals

The recommendations in this interactive flowchart represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, health professionals are expected to take these recommendations fully into account, alongside the individual needs, preferences and values of their patients. The application of the recommendations in this interactive flowchart is at the discretion of health professionals and their individual patients and do not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or their carer or guardian.

Commissioners and/or providers have a responsibility to provide the funding required to enable the recommendations to be applied when individual health professionals and their patients wish to use it, in accordance with the NHS Constitution. They should do so in light of their duties to

have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should assess and reduce the environmental impact of implementing NICE recommendations wherever possible.

Medical technologies guidance, diagnostics guidance and interventional procedures guidance

The recommendations in this interactive flowchart represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, healthcare professionals are expected to take these recommendations fully into account. However, the interactive flowchart does not override the individual responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or guardian or carer.

Commissioners and/or providers have a responsibility to implement the recommendations, in their local context, in light of their duties to have due regard to the need to eliminate unlawful discrimination, advance equality of opportunity, and foster good relations. Nothing in this interactive flowchart should be interpreted in a way that would be inconsistent with compliance with those duties.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should assess and reduce the environmental impact of implementing NICE recommendations wherever possible.