

## Joint Trust Guideline for the Management of Intravenous fluid infusion in children one month to 16 years

**A clinical guideline recommended for use**

<b>For Use in:</b>	Any area where children are managed
<b>By:</b>	All staff who manage children
<b>For:</b>	Children needing intravenous fluids (excludes neonates <1month old)
<b>Division responsible for document:</b>	Women and Children
<b>Key words:</b>	Child, paediatric, intravenous fluid infusion
<b>Name and job title of document author:</b>	Kathy Wilkinson , Consultant Paediatric Anaesthetist NNUH Ruchi Arora, Consultant Paediatrician NNUH
<b>Name of document author's Line Manager:</b>	Milind Kulkarni
<b>Job title of author's Line Manager:</b>	Clinical Director Paediatrics NNUH
<b>Supported by:</b>	Dr E Bentsi-Enchill Locum Consultant Paediatrics JPUH
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<b>Compliance links: (is there any NICE related to guidance)</b>	NICE CG29 2020 Surveillance of intravenous fluid therapy in children and young people in hospital (NICE guideline NG29)
<b>If Yes - does the strategy/policy deviate from the recommendations of NICE? If so why?</b>	No deviation

This guideline has been approved by the Trust's Clinical Guidelines Assessment Panel as an aid to the diagnosis and management of relevant patients and clinical circumstances. Not every patient or situation fits neatly into a standard guideline scenario and the guideline must be interpreted and applied in practice in the light of prevailing clinical circumstances, the diagnostic and treatment options available and the professional judgement, knowledge and expertise of relevant clinicians. It is advised that the rationale for any departure from relevant guidance should be documented in the patient's case notes.

The Trust's guidelines are made publicly available as part of the collective endeavour to continuously improve the quality of healthcare through sharing medical experience and knowledge. The Trust accepts no responsibility for any misunderstanding or misapplication of this document.

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### Version and Document Control:

Version Number	Date of Update	Change Description	Author
1	24/02/2015	Change of header and footer to joint hospital version. Removal of all references to Hartmann's with 1% glucose. Page 3 Box C amendment. Amendment to ward name PAU	Kathy Wilkinson , Ruchi Arora
2	09/08/2016	Fluid restriction changed from 66% or 2/3rd to 50-80% Definition of hypernatraemia changed from 160 to 145 mmol/L The addition of daily glucose in box C - monitoring and Clinical Audit Standard, NICE guidelines in Reference section	Kathy Wilkinson , Ruchi Arora
3	09/10/2017	Page 4 under Fluid type - Added Chronic Kidney Disease to list i.e. " If Hypernatraemia, Diabetes, Chronic Kidney Disease, or in response to U&E results:" Addition of Appendix 2 and 3 charts as suggested by JPUH	Kathy Wilkinson , Ruchi Arora
4	23/11/2020	units added for Sodium Chloride and Hartmans, wording amended	Kathy Wilkinson , Ruchi Arora

### This is a Controlled Document

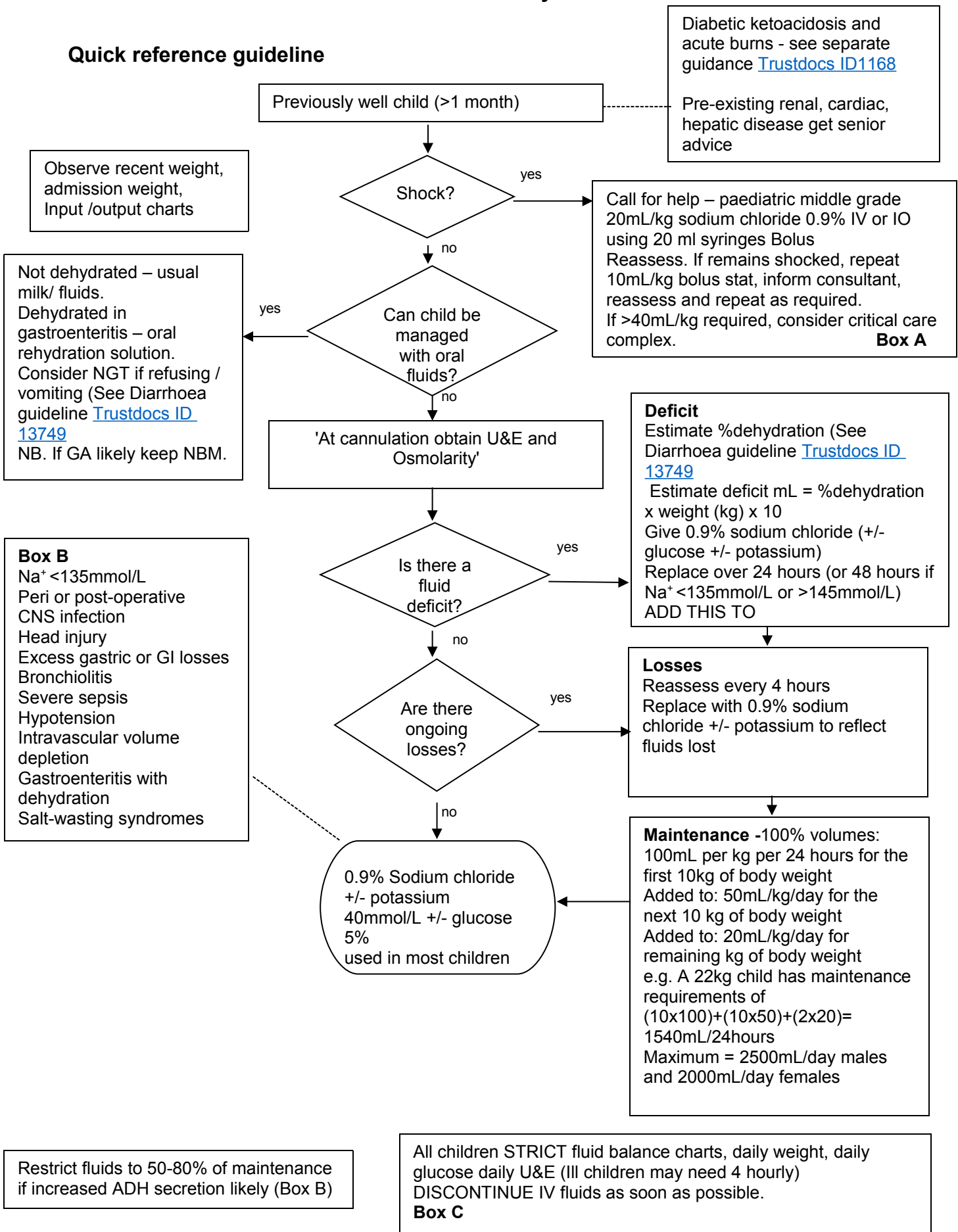
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### Abbreviations

ADH	Anti-diuretic Hormone
GA	General Anaesthetic
GI	Gastro-intestinal
IO	Intraosseous
IVI	Intravenous infusion
NBM	Nil by mouth
NPSA	National Patient Safety Agency
TPN	Total Parenteral Nutrition
U&E	Urea and Electrolytes

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## Quick reference guideline



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## Box A - Resuscitation fluids in shock

- Is the child shocked? (Assess whole picture – pulse rate and volume, central capillary refill time, respiratory rate, oxygen saturation, blood pressure, urine output, level of consciousness, peripheral/core temperature gap, recent weight loss)
- If shocked call for help (SpR or consultant) and give 20mL/kg of 0.9% sodium chloride as a bolus stat using 20 mL syringe.
- If child remains shocked give aliquots of 10mL/kg 0.9% sodium chloride or any glucose free isotonic crystalloid with a Na content of 131-154 mmol/L.
- A child with non-haemorrhagic hypovolaemic shock should respond to 40mL/kg. Children requiring more than 40mL/kg of resuscitation fluid are usually best cared for in the critical care complex where serious consideration should be given to the need for intubation. Inform consultant and consider reasons for resistant shock e.g. sepsis, intestinal ischaemia, myocardial dysfunction, pneumothorax, pericardial effusion, adrenocortical insufficiency, pulmonary hypertension.

## Box B - Principles of fluid replacement

- 0.45%/5% should NOT be used as default fluid when commencing maintenance EXCEPT as recommended in Diabetes guidelines or if sodium and/or chloride is rising.
- Do not use Intravenous infusions (IVI) unless absolutely necessary. Most children admitted to hospital are able to tolerate oral fluids. If in doubt, trial of oral fluids with careful monitoring of fluid balance is warranted prior to resorting to IVI.
- Oral or nasogastric (NG) fluids are safest, provide calories (if able to tolerate milk feeds) and are comforting for the child.
- Most babies and children may now drink clear fluids for up to 1 hour before planned (non-emergency) surgery – Cross reference pre-operative fluids guideline here
- IV fluids may be required in severe illness. However Antidiuretic Hormone (ADH) is produced in response to serious illness, pain, dehydration, in response to surgery (see Box B) ADH leads to reduced urine output, concentrated urine and retention of 'water' and can result in hyponatraemia. Maintenance fluid requirements in illness are therefore LESS than maintenance fluid requirements in health. Maintenance fluids in illness should be restricted to 50-80% of calculated requirements (see below).
- 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 second 10 kg of weight.
  - 20 ml/kg/day for the weight over 20 kg.
  - Be aware that over a 24-hour period, males rarely need more than 2500 ml and females rarely need more than 2000 ml.
- All children must have electrolytes measured when inserting cannula for IVI. Requesting serum osmolality is helpful in determining hydration status.

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- As a rule SLOW correction of abnormalities in sodium is best.
- See specific 'disease' guidelines for tailored management (diarrhoea with or without vomiting, diabetic ketoacidosis).
- Consider alternative calculation in high risk groups following discussion with specialist teams.

### Box C - Monitoring

- Children who are on IV fluids require a strict fluid balance chart with monitoring of all inputs (including drug volumes), outputs, daily weights, U&E and glucose measurements.
- Monitor U&E at least every 24 hours whilst on IVI. More frequently if electrolytes are abnormal, severe illness, DKA Follow [Trustdocs ID 1168](#) and measure 4-6 hourly if  $\text{Na} < 130 \text{ mmol/L}$ . A capillary sample for a blood gas machine (with electrolyte analysis) can be used for trends, with a proper blood sample sent to the lab for U&E as a minimum daily.

### Fluid volumes in dehydration (See also Diarrhoea guideline [Trustdocs ID 13749](#))

- Calculate deficit to be replaced over 24 hours (or 48 hrs if hypo/hypernatraemia).
- Add to this maintenance fluid requirement in 24 hours (full / 100% maintenance).
- Add to this ongoing losses

Losses should be replaced mL for mL with a solution roughly comparable to this loss e.g. NG loss with 0.9% sodium chloride with 10mmol KCl per 500mL.

Write up total fluid required in 24 hours (which should include drug volumes) and hourly rate.

### Fluid volumes without dehydration

- The majority of children requiring IV fluids are sick and will be 'fluid retaining' under the influence of ADH (Box B). In this case, fluids should be restricted to 50-80% of maintenance volumes.
- In a well child, full maintenance can be given.

### Fluid Type (See Appendix 2)

- In those at risk of ADH secretion (Box B):
  - Sodium chloride 0.9% (Na 154, Cl 154 mmol/l NO Potassium) (with glucose 5% in infants under 1 year and consider glucose requirement in older children)
  - Compound sodium lactate's (Na 131, K 5, Cl 111, Ca, Lactate 29 mmol/L)  
<https://www.medicines.org.uk/emc/product/1812/smpc#gref>
- If Hypernatremia, Diabetes, Chronic Kidney Disease or in response to U&E results:
  - Sodium Chloride 0.45% with 2.5% or 5% glucose

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- Rarely children with known metabolic disorders come to CAU and need 10% glucose with 0.45% sodium chloride. Please see appendix 1 for instruction on how to make this up.

### Potassium replacement

- Potassium requirements are approx 2mmol/kg/day. Once the plasma potassium is known, and child has passed urine, 500mL bags with 10mmol KCl pre-added should be used. If potassium is low, 20mmol/500mL is used. Higher concentrations may be used at the discretion of the consultant (consider cardiac monitoring/ central line insertion). Pharmacy stock sodium chloride 0.9% with 60mmol/litre, 80mmol/litre or 40mmol/500mL.

### Hypoglycaemia

- Medical emergency - Give 2mL/Kg of 10% glucose. Recheck level after 15 mins. Review maintenance fluids. Monitor.

### Peri-operative patients

#### Pre op

- **Elective lists:** at the discretion of the anaesthetist.
- **Emergency lists:** Children who are starved pre-op awaiting emergency surgery should have maintenance IV fluids commenced as per main guideline if they are waiting more than 6 hours.

#### Post op

- It is relatively uncommon to need to prescribe intravenous fluids post operatively. When necessary the anaesthetist or surgeon will generally prescribe these. ADH will be secreted, thus solutions should be isotonic and prescribed as 50-80% maintenance. Urine output is likely to be low (0.75mL/Kg/hr not unusual). Suggested fluids are either:
  - Sodium Chloride 0.9% and glucose 5% or compound sodium lactate
- It is common in infants and children (as in adults) for blood sugar to rise in the intra-operative and early post operative period. Providing excess sugar in this situation can be detrimental. Exceptions to this principle are:
  - Children with known metabolic abnormalities resulting in hypoglycaemia related to starvation (intravenous glucose may also need to be provided pre-op).
  - Babies and Children who have been receiving 10% glucose or TPN pre-operatively.
- **Urine output:** 0.75-1mL/Kg/hour may be within normal limits in the first 24 hours after surgery. If the volumes are less than 0.75mL/Kg/hr (measured over approx. 3 hours) assess the whole child - trends in pulse, BP, CRT, mucous membranes, skin turgor etc. and discuss with a senior surgical or anaesthetic colleague, before considering a fluid bolus or increasing IV fluids.

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If there are concerns about the possibility of hyper or hypoglycaemia, blood sugar should be measured at the bedside and solutions adjusted.

\*Child with **diabetes**: East of England Paediatric Diabetes Network Guideline [Trustdocs ID 7763](#)

## Symptomatic hyponatraemia

- Check U&E (Ca and Mg) if symptoms of nausea, vomiting, headache, irritability, altered consciousness, seizures or apnoea.

If Na <130mmol/L get senior advice immediately. If child is seizing, commence infusion of sodium chloride 3% solution. One mL/Kg of sodium chloride 3% will normally raise the serum sodium by 1mmol/L. Serum Na should be raised quickly until the child has regained consciousness and has stopped fitting or the serum Na is above 125mmol/L. The amount of Na required can be calculated according to the following formula:

- mmol of Na required = (130-present serum Na) x 0.6 x Weight (kg).
- sodium chloride 3% is made by withdrawing 5mL of sodium chloride 30% (available on NICU) and making it up to 50mL with water for injections. immediately prior to administration.

## Asymptomatic hyponatraemia (Na<135) with normovolaemia

- **Fluid restrict to 50% maintenance.**
- **If dehydrated use sodium chloride 0.9% as rehydration fluids.**

## Hypernatraemic dehydration (Na>145mmol/L)

- Give sodium chloride 0.9% correct deficit slowly (over 48 hours) to reduce the risk of neurological injury associated with a rapid fall in plasma sodium. The correction rate should be by no more than 12mmol/24hr. Sodium chloride 0.45% can also be used.

## Objective

To ensure appropriate volume and type of intravenous fluids are prescribed and given to children

## Rationale

Recent literature has emphasised important problems with standard IV fluid regimes in children (refs 1-6). This guideline follows recommendations from the NPSA to use isotonic solutions where the risk of hyponatraemia is high and to reduce the total volume of fluids where necessary. Evidence from randomised controlled trials is NOT available to inform practice. The guideline is therefore based on rational 'best practice' from the NPSA.

## Broad recommendations

## Joint Trust Guideline for the Management of Intravenous fluid infusion in children one month to 16 years

Isotonic solutions (sodium chloride 0.9%) should usually be used for IVI in children, and the volumes should usually be restricted to 50-80% standard maintenance.

### Clinical audit standards

- All children should have a U&E and glucose measured before an IVI is commenced except in resuscitation situations or replacement for very limited duration during surgery.
- The U&E result must be looked at and used to inform further fluid management.
- IV infusions should only be used where indicated (see guideline).
- 0.9% sodium chloride (with or without glucose / potassium) should be used as initial fluids. If there is NO risk of ADH secretion then 0.45% sodium chloride with 5% glucose (with or without potassium) can be used.
- A further U&E sample should be taken by 24 hours or less of commencing IV fluids and the fluids should be adjusted according to results.
- Children who are ill enough to require an IVI should be monitored with a strict fluid balance chart.
- Children who are 'nil-by-mouth' or not fully established on enteral feeding should have a U&E checked daily.
- Children's Na<sup>+</sup> and K<sup>+</sup> should be kept within the normal range.

### Summary of development and consultation process undertaken before registration and dissemination

Kate Armon and Kathy Wilkinson developed the guideline in consultation with paediatric medical, surgical and anaesthetic colleagues. During its development it has been circulated for comment to: nursing staff in all paediatric areas, pharmacy, accident and emergency department. In November 2020 document was reviewed by Kathy Wilkinson and Ruchi Arora, however because of the Covid situation this did not get loaded.

This version has been endorsed by the Clinical Guidelines Assessment Panel.

### Distribution list / dissemination method

Hospital intranet and distribution to paediatric areas.

### References/ source documents

1. Taylor D, Durward A. Pouring salt on troubled waters. *Arch Dis Child* 2004;**89**:411-414
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5. Halberthal M, Halperin ML, Bohn D. Acute hyponatraemia in children admitted to hospital: retrospective analysis of factors contributing to its development and resolution. *BMJ* 2001;**322**:780-782
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7. National Patient Safety Agency Patient safety alert 22. Reducing the risk of hyponatraemia when administering intravenous infusions to children. 28/3/07
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9. National Clinical Guideline Centre. IV Fluids in Children: Intravenous Fluid Therapy in Children and Young People in Hospital. London: National Institute for Health and Care Excellence (UK); 2015 Dec. (NICE Guideline, No. 29.) Available from: <https://www.nice.org.uk/guidance/ng29>.
10. BSPED Guideline for the Management of Children and Young People under the age of 18 years with Diabetic Ketoacidosis [Trustdocs ID 1168](#)
11. East of England Paediatric Diabetes Network Guideline [Trustdocs ID 7763](#)
12. Management of Post-Operative Nausea and Vomiting in Adults and Children (clinical guideline) [Trustdocs Id 13749](#)

# Joint Trust Guideline for the Management of Intravenous fluid infusion in children one month to 16 years

## Appendix 1

10% Glucose with 0.45% Sodium Chloride  
For patients with Metabolic Disease

Some patients with metabolic disease such as MCADD require this infusion fluid, for treatment of metabolic crises. This solution is not available as a ready-made solution and must be prepared each time it is required.

### Preparation instructions

- Take 500mL bag of 0.45% Sodium Chloride
- Withdraw 100mL of fluid
- Add 100mL of 50% Glucose to fluid bag
- Affix additive label
- If necessary, add potassium

In patients with shock or significant hyponatraemia, it is desirable to use 0.9% Sodium Chloride (“Normal Saline”) with 10% glucose. In this instance, use a bag of 500mL of 0.9% Sodium Chloride, instead of 0.45% Sodium Chloride.

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## Appendix 2

Composition of Commonly used Intravenous Fluids:

Fluid	Na (mmol/l)	K (mmol/L)	Cl (mmol/l)	Glucose(g/100ml)
0.9% Sodium chloride	154	-	154	-
5% glucose 0.45% sodium chloride	78	-	78	5
5% Glucose 0.9% sodium chloride	156	-	156	5
4% glucose 0.18% sodium chloride	30	-	30	4
5% glucose				5
2.5% glucose 0.45% sodium chloride	78		78	2.5
Compound sodium lactate	131	5	111	
Plasma-lyte 148®	140	5	98	

Note: 0.45% solution alone is a hypotonic solution and its use is severely restricted.

NB – Water for Injection only to be used as a diluent.  
Absolutely contraindicated as an infusion.

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## Appendix 3

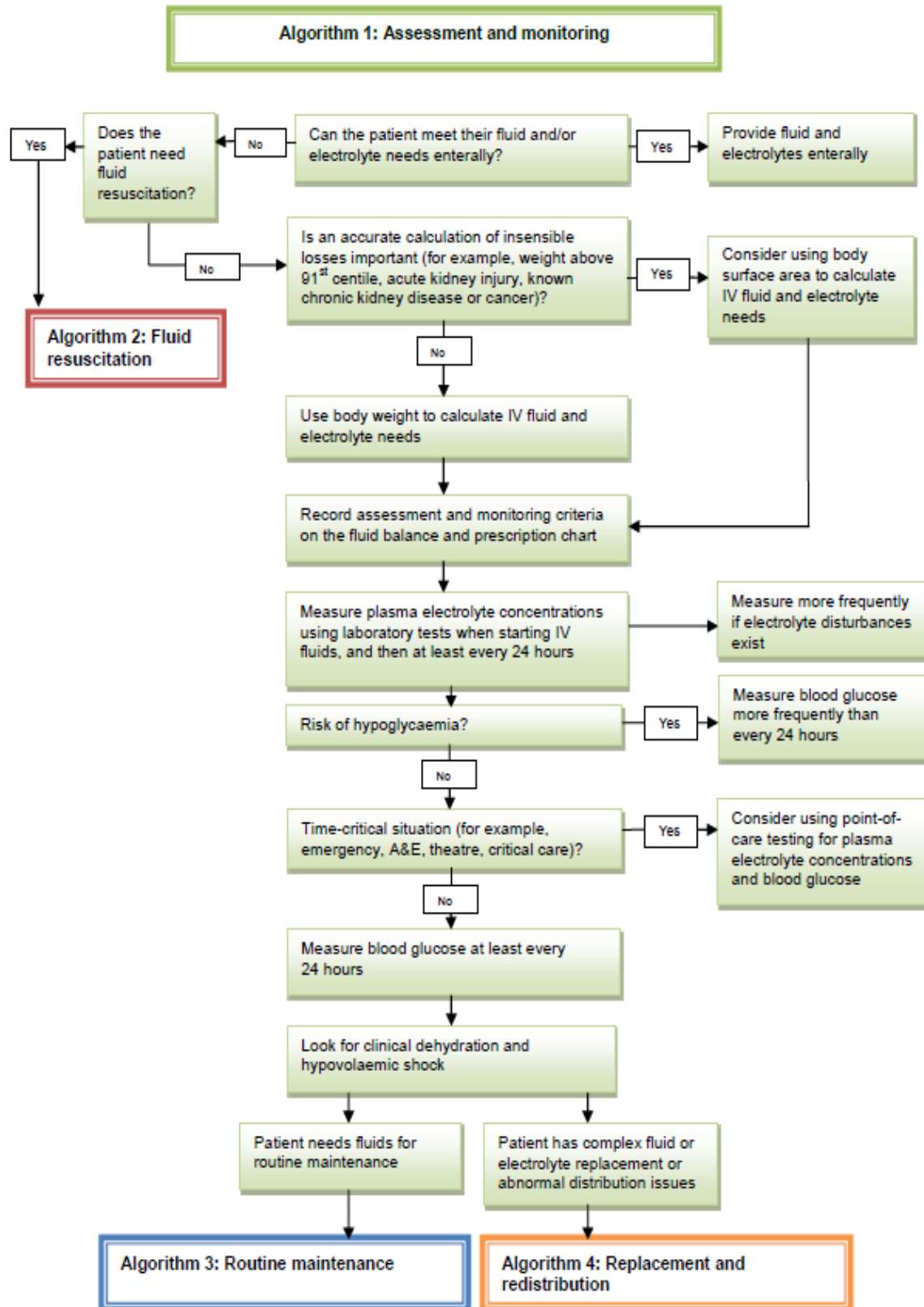
### Intravenous fluid types for children and young people

Fluid with recommendation reference	Fluid type <sup>a</sup>	Osmolality (compared with plasma)	Tonicity (with reference to cell membrane)	Sodium content (mmol/litre)	Potassium content (mmol/litre)
Isotonic crystalloids that contain sodium in the range 131–154 mmol/litre	0.9% sodium chloride	Isosmolar	Isotonic	154	0
	Hartmann's solution	Isosmolar	Isotonic	131	5
Isotonic crystalloids with glucose that contain sodium in the range 131–154 mmol/litre	0.9% sodium chloride with 5% glucose	Hyperosmolar	Isotonic	150	0
Hypotonic fluids	0.45% sodium chloride with 5% glucose	Hyperosmolar	Hypotonic	75	0
	0.45% sodium chloride with 2.5% glucose	Isosmolar	Hypotonic	75	0
	0.45% sodium chloride	Hyposmolar	Hypotonic	75	0
	5% glucose	Isosmolar	Hypotonic	0	0
	10% glucose	Hyperosmolar	Hypotonic	0	0

<sup>a</sup> Fluids given are examples of appropriate fluids; for further details, see the [British national formulary for children](#).

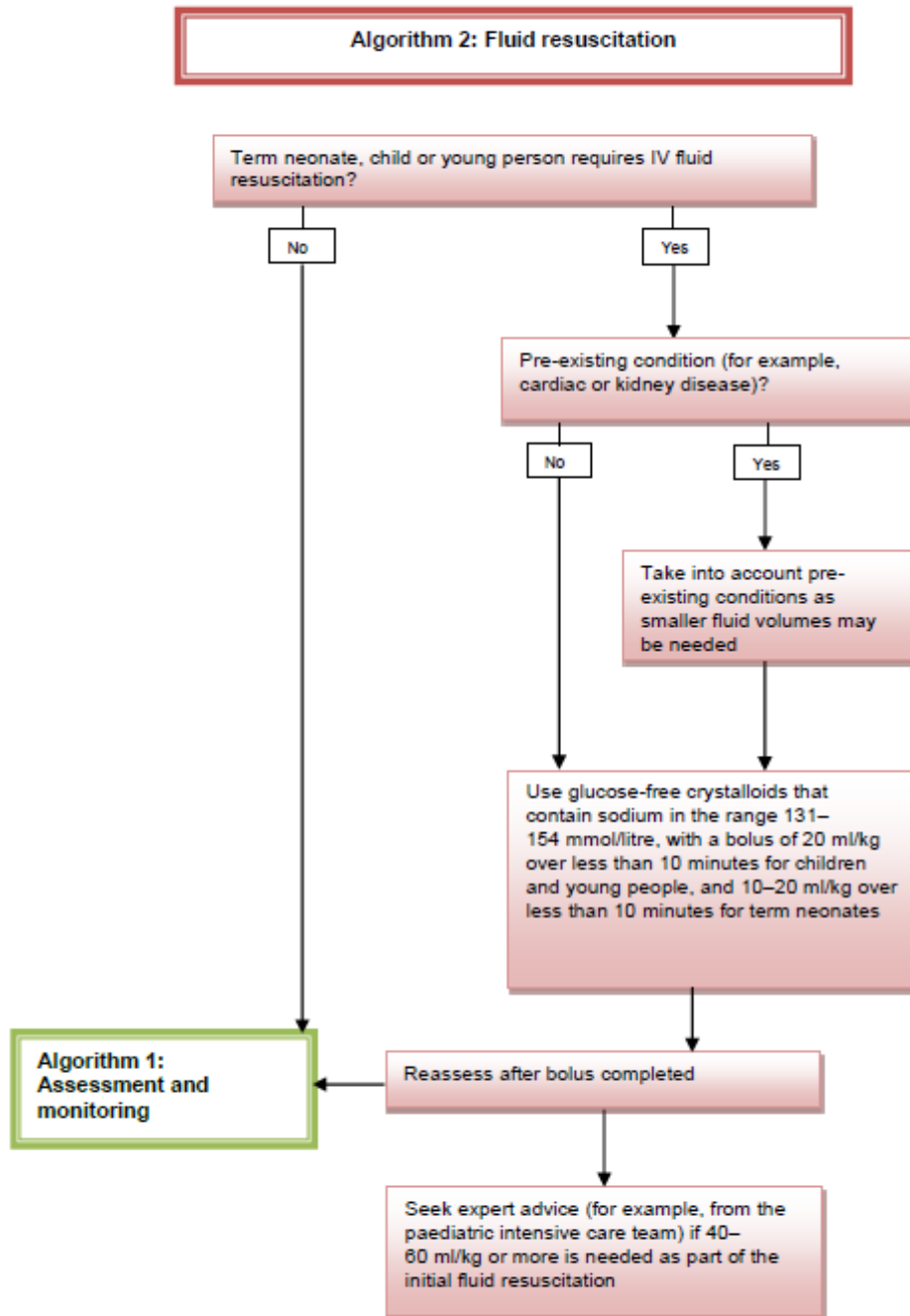
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## Algorithms for IV fluid therapy in children and young people in hospital



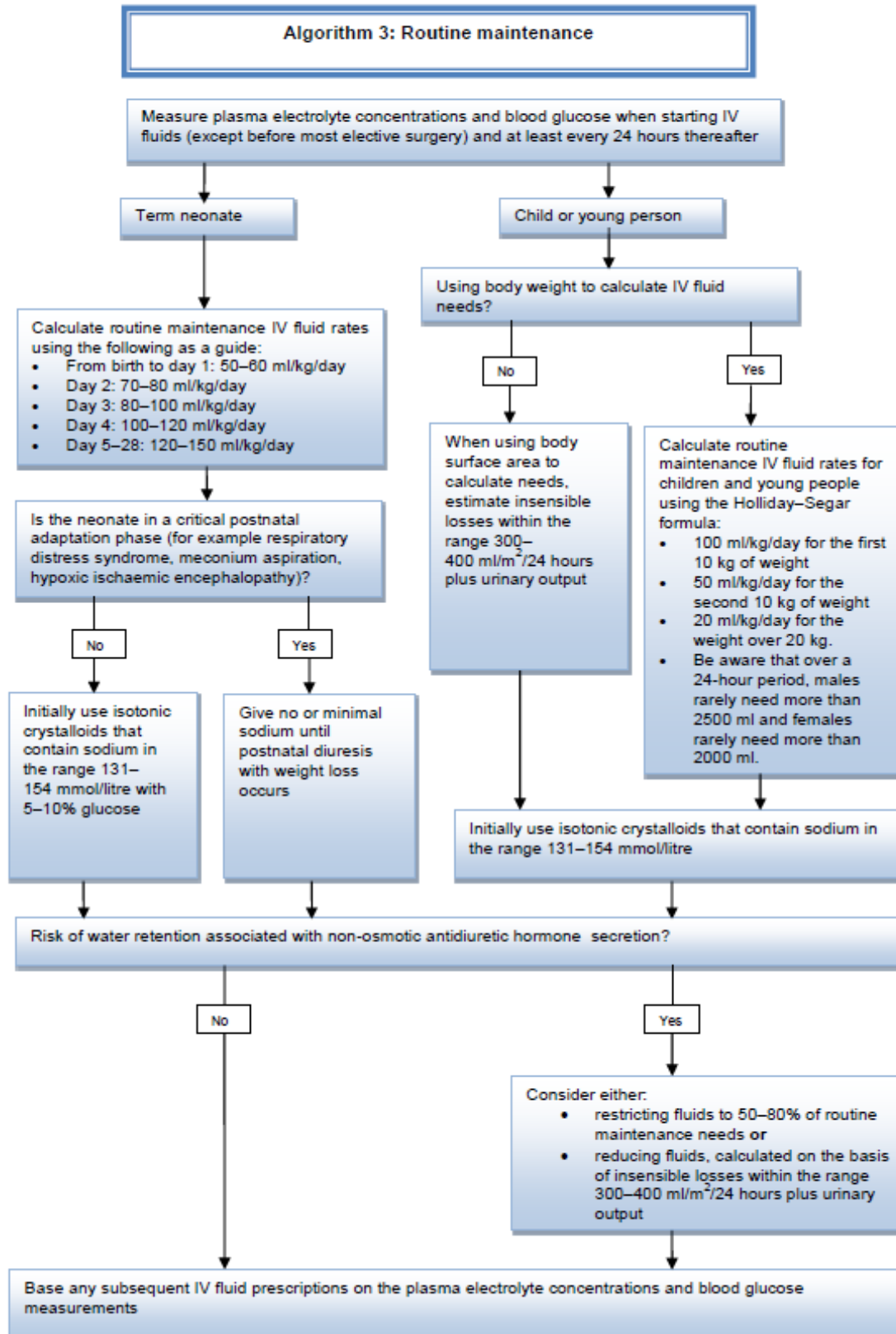
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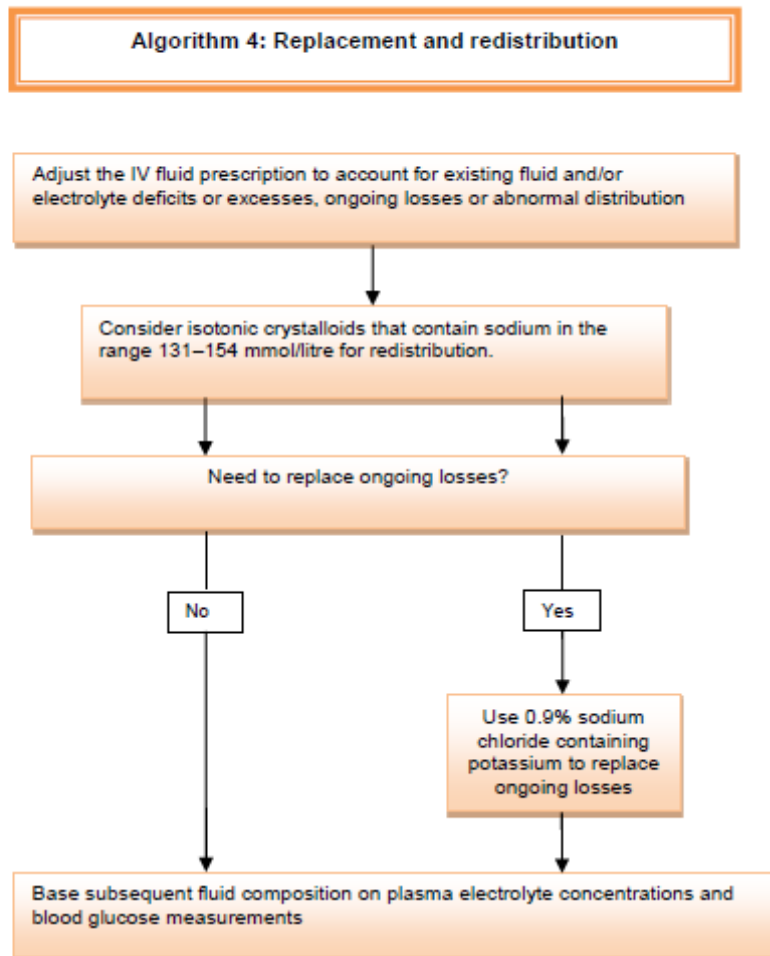
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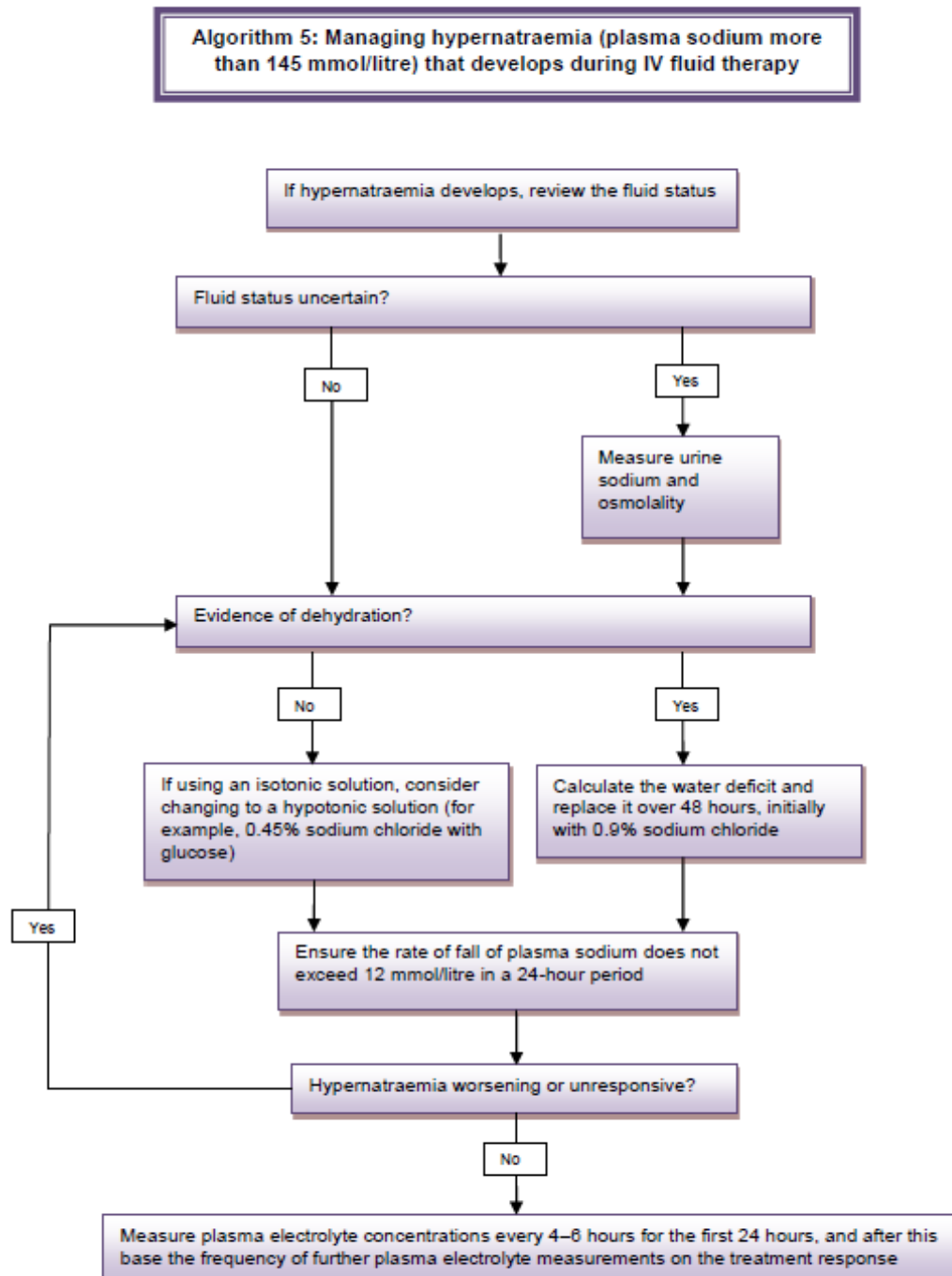
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## Algorithms for IV fluid therapy in children and young people in hospital

### Algorithm 6: Managing hyponatraemia (plasma sodium less than 135 mmol/litre) that develops during IV fluid therapy

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

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

