

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

A clinical guideline recommended for use

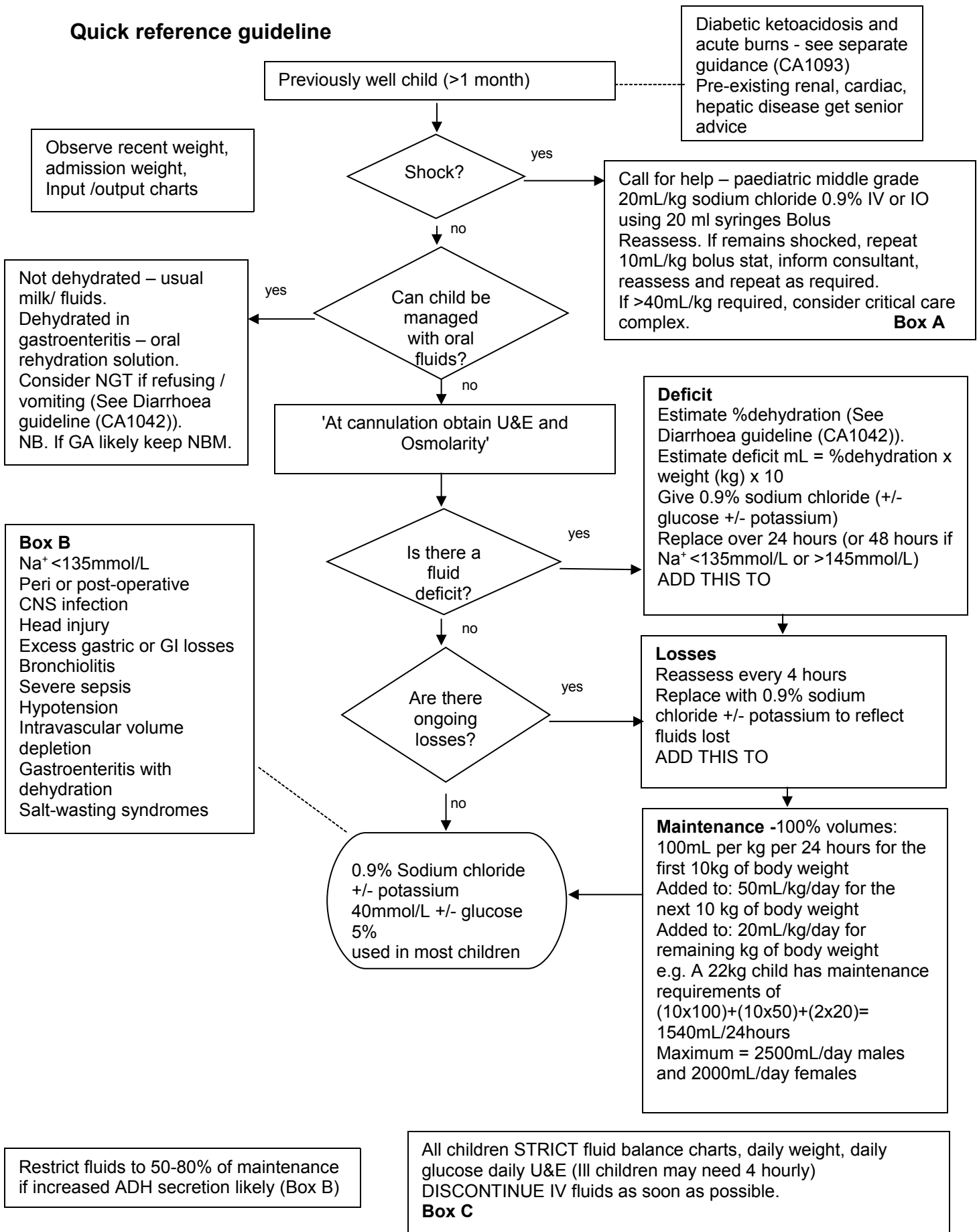
For Use in:	Any area where children are managed
By:	All staff who manage children
For:	Children needing intravenous fluids (excludes neonates <1month old)
Division responsible for document:	Women and Children
Key words:	Child, paediatric, intravenous fluid infusion
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Version No:	3
Description of changes:	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
Compliance links: (is there any NICE related to guidance)	NICE CG29
If Yes - does the strategy/policy deviate from the recommendations of NICE? If so why?	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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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 now 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.
- IV fluids may be required in severe illness. 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.
- Repeat electrolytes between 12-24 hours if IVI will continue, or sooner if indicated (e.g. ongoing losses, deranged U&E, severe illness, DKA – follow guideline CA 1093).
- Monitor U&E at least every 24 hours whilst on IVI. More frequently if electrolytes are abnormal, 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 (CA1042)).

- 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

- In those at risk of ADH secretion (Box B):
 - Sodium chloride 0.9% (with glucose 5% in infants under 1 year and consider glucose requirement in older children)
 - Hartmann's solution
- 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% saline. 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 Hartmann's solution
- 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

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turgor etc. and discuss with a senior surgical or anaesthetic colleague, before considering a fluid bolus or increasing IV fluids.

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**: Please see trust guideline for peri-operative fluids in the Diabetic child (CA1010).

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

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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

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.
- 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⁺ and K⁺ should be kept within the normal range.

Summary of development and consultation process undertaken before registration and dissemination

Kate Armon 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.

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

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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>

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

Version Information

Version No	Updated By	Updated On	Description of Changes
JCG0090v1	THCGAP	24 February 2015	Change of header & 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
JCG0090v2		09 August 2016	Fluid restriction changed from 66% or 2/3 rd to 50-80% Definition of hypernatraemia changed from 160 to 145 mmol/L The addition of daily glucose in box C - monitoring

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			and Clinical Audit Standard NICE guidelines in Reference section

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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% Saline	156	-	156	-
5% dex 0.45% saline	78	-	78	5
5% Dex 0.9% saline	156	-	156	5
4% dex 0.18% saline	30	-	30	4
5% dextrose				5
2.5% dex 0.45% saline	78		78	2.5
Hartmanns	131	5	111	
Plasma-lyte 148®	140	5	98	
Plasma-lyte 148®+5% Dex	140	5	98	5

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

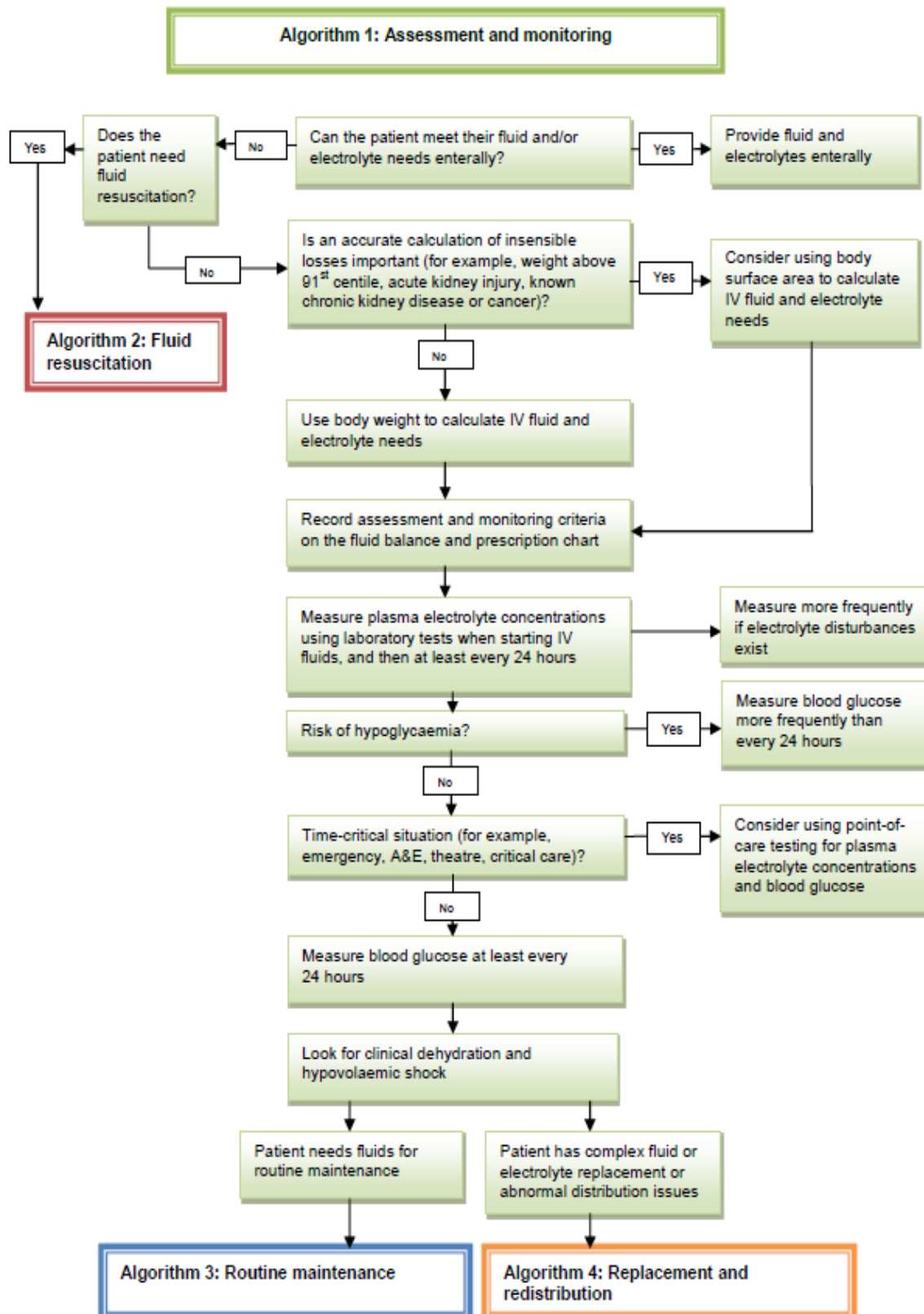
Intravenous fluid types for children and young people

Fluid with recommendation reference	Fluid type ^a	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 [1.3.1, 1.3.2, 1.4.3, 1.5.2, 1.6.1, 1.7.1]	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 [1.4.7]	0.9% sodium chloride with 5% glucose	Hyperosmolar	Isotonic	150	0
Hypotonic fluids [1.6.1, 1.7.1]	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

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

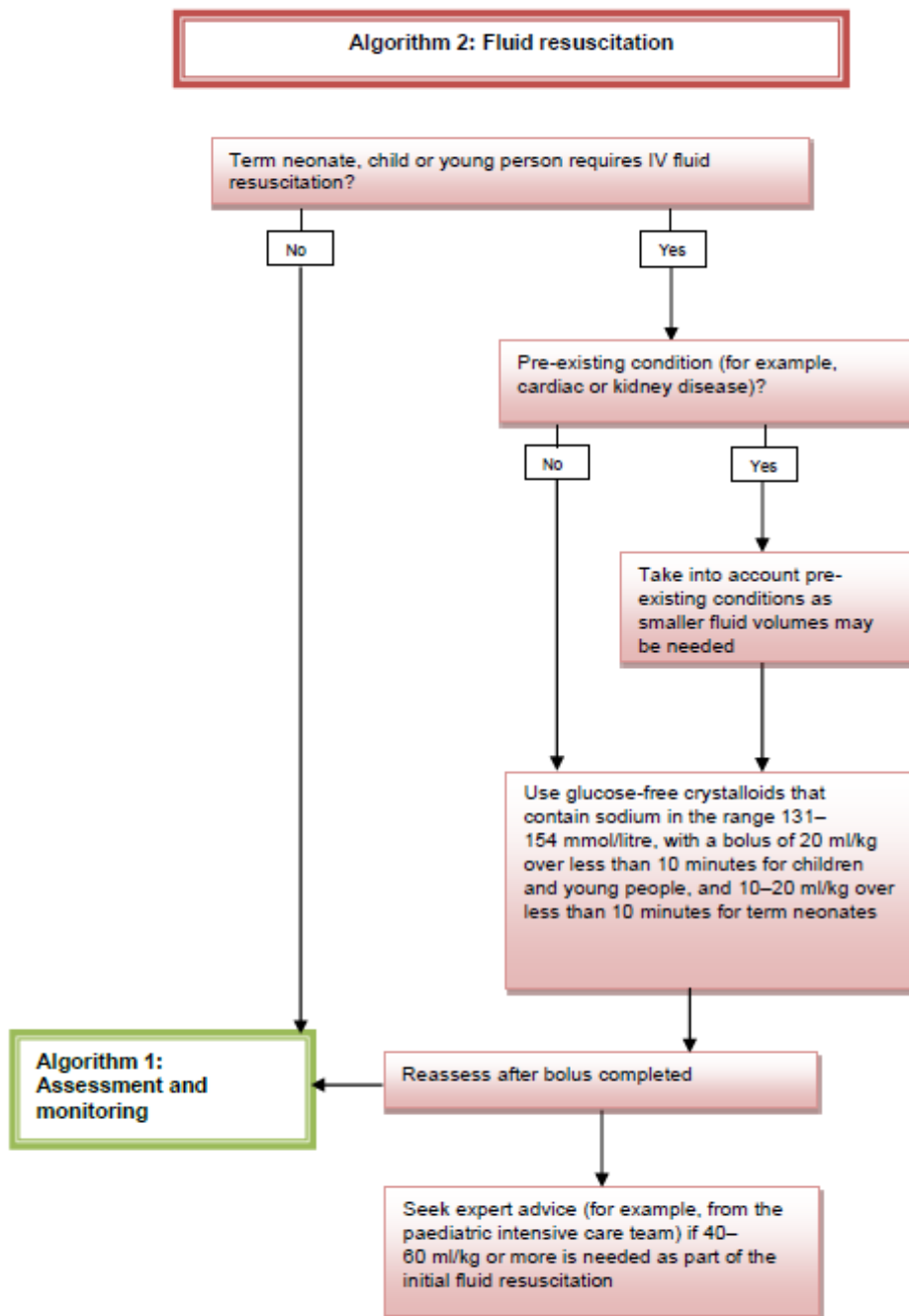
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Algorithms for IV fluid therapy in children and young people in hospital



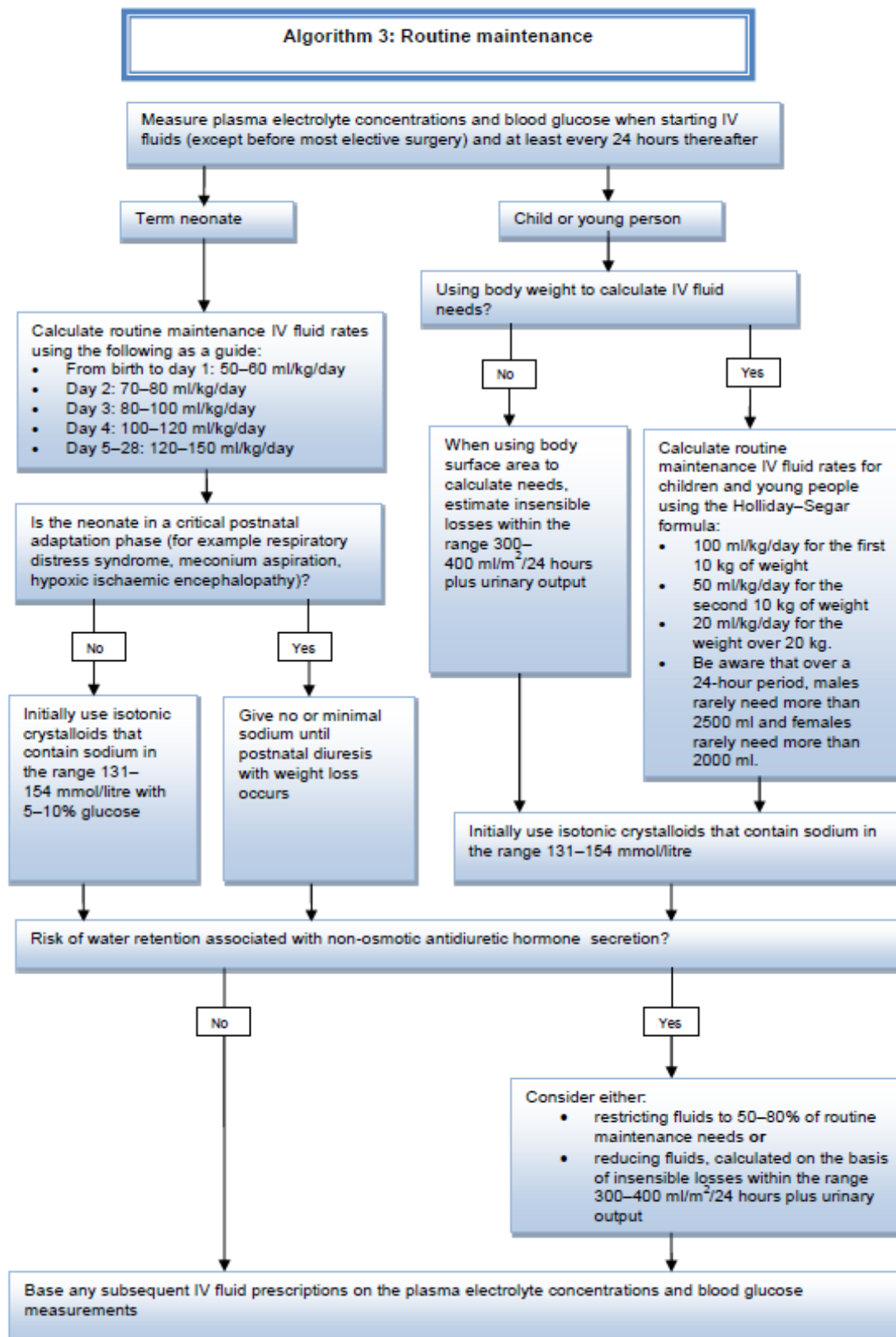
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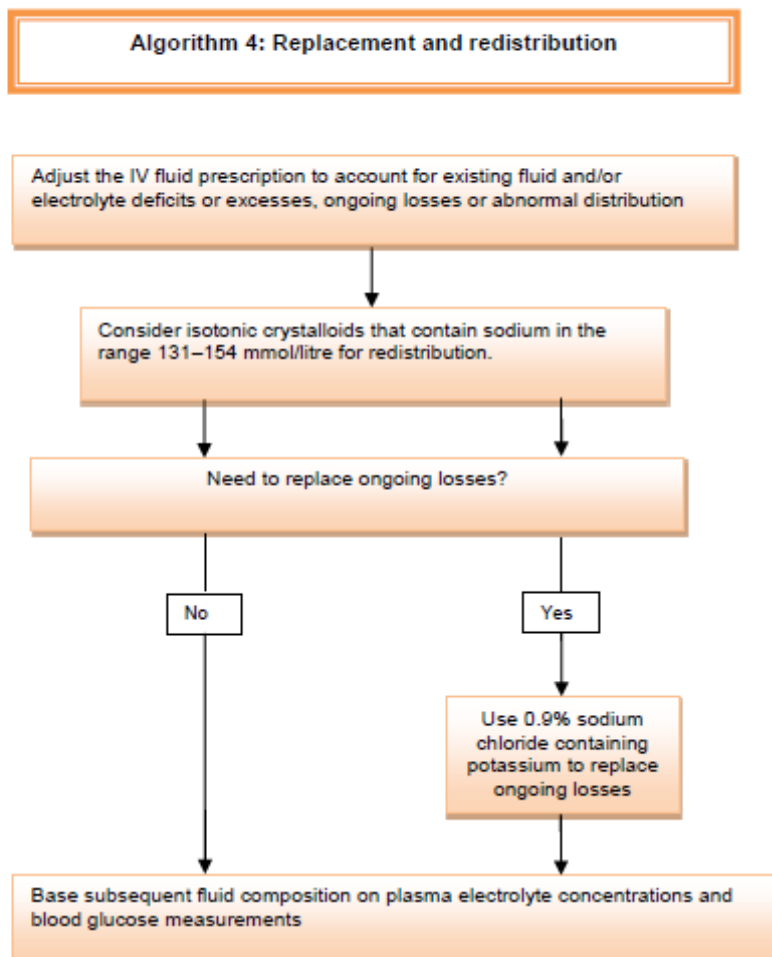
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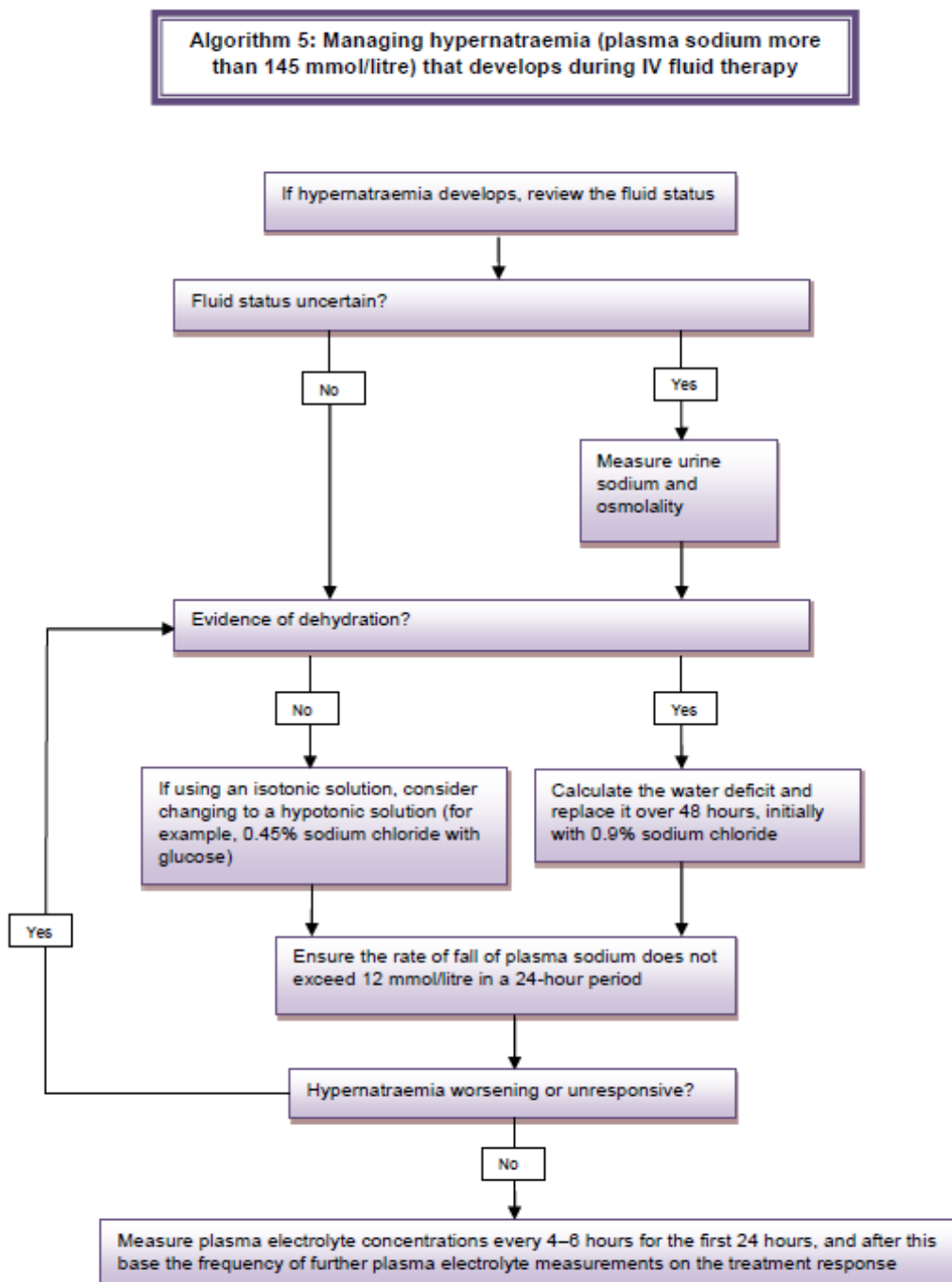
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Algorithm 6: Managing hyponatraemia (plasma sodium less than 135 mmol/litre) that develops during IV fluid therapy

