INTRAVENOUS FLUID AND ELECTROLYTE THERAPY

PRACTICE GUIDELINE ©

DOCUMENT SUMMARY/KEY POINTS

- This guideline is to recommend **initial** (first 8 hours) fluid and electrolyte therapy and make recommendations relevant to ongoing fluid and electrolyte management.
- All children, particularly neonates and infants are vulnerable to injury from inappropriate intravenous fluid use.
- 1000 mL (1 litre) Intravenous Fluid bags are used for paediatric patients; 500 mL bags are used for neonates (less than one month corrected).
- Unwell Children should be managed according to the following:
  - Treat SHOCK / HYPOVOLAEMIA
  - Replace DEFICIT / DEHYDRATION
  - Replace ONGOING LOSSES
  - Provide MAINTENANCE REQUIREMENT
  - Re-evaluate OFTEN
- Maintenance Fluids:
  - Children under 1 month of age should be initiated on sodium chloride 0.45% + glucose 10% +/- potassium chloride 10 mmol/500 mL and blood glucose checked daily. (This excludes neonates in intensive care and Special Care Nurseries),
  - Children 1 month and older should be initiated on maintenance with sodium chloride 0.9% + glucose 5% +/- potassium chloride 20 mmol/1000 mL.
  - Alternatively, and ONLY under direction of a consultant sodium chloride 0.45% + glucose 5% +/- potassium chloride 20 mmol/1000 mL or Plasma-Lyte 148 + 5% glucose (contains potassium chloride 5 mmol/1000 mL), may be used.

Approved by:	SCHN Policy, Procedure and Guideline Committee	
Date Effective:	1st February 2024	**Review Period**: 3 years
Team Leader:	Associate Director	**Area/Dept**: General Paediatrics CHW

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This guideline should be read in conjunction with:

- SCHN Medication Administration Practice Guideline: http://webapps.schn.health.nsw.gov.au/epolicy/policy/5024
- SCHN CVAD Practice Guideline: http://webapps.schn.health.nsw.gov.au/epolicy/policy/5119
- SCHN Parenteral Nutrition Practice Guideline: http://webapps.schn.health.nsw.gov.au/epolicy/policy/4998
- SCHN Peripheral Intravenous Catheters – Clinical Standard: http://webapps.schn.health.nsw.gov.au/epolicy/policy/4901
- SCHN Intravenous Extravasation – Management Practice Guideline: http://webapps.schn.health.nsw.gov.au/epolicy/policy/5066
- PICU Water and Electrolyte management in PICU – CHW Practice Guideline: http://webapps.schn.health.nsw.gov.au/epolicy/policy/5151
- Paediatric Improvement Collaborative (PIC) Intravenous Fluids: https://www.rch.org.au/clinicalguide/guideline_index/Intravenous_fluids/
- Paediatric Improvement Collaborative (PIC) Neonatal Intravenous Fluids: https://www.rch.org.au/clinicalguide/guideline_index/Neonatal_intravenous_fluids/
- NSW Health Intravascular Access Devices (IVAD) - Infection Prevention & Control Policy: https://www1.health.nsw.gov.au/pds/Pages/doc.aspx?dn=PD2019_040

CHANGE SUMMARY

- Network document created from SCH IV Fluid and Electrolyte Therapy Practice Guideline. CHW IV Fluid Practice Guideline has been rescinded.
- **Minor review 2/7/24**:
  - Added links to PIC Intravenous Fluids Guidelines (paediatric and neonatal) and removed access to obsolete NSW Health IV Fluid Guideline.
  - Capped daily IV fluid requirements to <=45 kg in table 1.
- **Minor review 27/11/24:** Added example for Fluid deficit calculations.
- **Minor review 10/02/25:** Corrections made, and an example added to Table A (page 5).
- **Minor review 10/04/25:** corrected table A page 5.

READ ACKNOWLEDGEMENT

- All Clinical staff prescribing and administering IV fluids must read and acknowledge this document (e.g., sign-off after reading it to acknowledge they understand it).

TABLE OF CONTENTS

1 Background

All children, particularly neonates and infants, are vulnerable to injury from inappropriate intravenous fluid use. Correct choice of fluid and electrolyte therapy is therefore very important.

This guideline aims to recommend initial (first 8 hours) fluid and electrolyte therapy and make recommendations relevant to ongoing fluid and electrolyte management.

Variations from the guideline will be necessary according to specific needs of individual children, or specialised clinical situations. Management of complex fluid and electrolyte problems are beyond the scope of this guideline.

Requirements for fluid administration

- Paediatric infusion sets with inline burette must be used for all children requiring intravenous therapy. An infusion pump should be used for all children[1].
- All user-applied labelling of injectable medicines, fluids and lines to follow the National Standard.
- Hourly observations of the IV fluids and IV cannula site.
- Frequency of line change: refer to Table 7 in NSW Health IVAD Infection Prevention and Control Procedure.
- Documentation:
  - prescribing and documenting administration in MAR
  - observations, including position of cannula/site checks
  - date/time of infusion set change and date/time of infusion set due to be changed.

2 Maintenance fluids

Maintenance fluid is that volume of daily fluid intake which replaces the insensible losses (from breathing, skin, stools), plus a volume that allows excretion of waste (urea, creatinine, electrolytes etc) in urine of similar osmolarity to plasma.

Relatively well children with initially normal hydration, who are fasted (nil by mouth), or are unable to drink for more than six hours may require maintenance fluid.

Newborn infants (especially pre-term) have relatively large insensible water loss via the skin. There is often confusion about the difference between oral and IV fluid requirements for young infants. The fluid requirement is identical for both routes of administration.

The following calculations approximate the maintenance fluid requirement of well children (not pre-term) according to weight in kg to a maximum of 50kg. Children over 50kg should not require prescription of additional maintenance fluid since the standard requirement for a 70kg adult is 2 litres per 24 hours. Obese children should have maintenance fluid prescribed according to ideal body weight (95th percentile for age) to avoid iatrogenic fluid overload.

Table A

Patient age/weight	Daily IV requirements	Hourly IV requirements
Day 1 of life	60 mL/kg	2.5 mL/kg
Day 2 of life	90 mL/kg	3.75 mL/kg
Day 3 – 28 of life	120 mL/kg	5 mL/kg
Beyond 28 days		
3 - 10kg	**100** mL/kg	**4** mL/kg
10 – 20kg	1000 + **50** x [wt (kg) – 10] mL	40 + **2** x [wt (kg) – 10] mL
> 20 kg	1500 + **20** x [wt (kg) – 20] mL	60 + **1** x [wt (kg) – 20] mL
>= 50kg	2000 mL	83 mL
Example – child weighing **22kg**	**(100-50-20 method: daily IV requirements)** 1-10kg: **100** x 10 = 1000mL 10-20kg: **50** x 10 = 500mL >20kg: **20** x 2 = 40mL Daily IV requirement: 1000 + 500 +40 = 1540 mL/day **Rate:64mL/h**	**(4-2-1 method: hourly IV requirement)** 1 - 10kg: **4** x10 = 40mL/h 10-20kg: **2** x 10 = 20mL/h >20kg: **1** x 2 = 2 mL/h Hourly IV requirement: 40 +20 + 2 = 62 **Rate: 62mL/h**

2.1 Initial Maintenance Fluids

When ordering IV fluids the prescription must be written in full such as:

"sodium chloride 0.9% + glucose 5%"

Alternatives such as dextrose & abbreviations such as NaCl, N/S and N/2 must not be used.

Under 1 month old

- sodium chloride 0.45% + glucose 10% +/- potassium chloride 10 mmol/500 mL. Check urine for glycosuria daily.
- If glycosuria, consider a solution with reduced glucose e.g., sodium chloride 0.45% + glucose 5% +/- potassium chloride 10 mmol/500 mL.

1 month or older

- sodium chloride 0.9% + glucose 5% +/- potassium chloride 20 mmol/1000 mL.
- Alternatively, and ONLY under direction of a consultant:
  - sodium chloride 0.45% + glucose 5% +/- potassium chloride 20 mmol/1000mL **or**
  - Plasma-Lyte 148 + glucose 5% (note this solution contains 5 mmol/L potassium chloride per litre), may be used.

If urine output has been established and serum potassium and creatinine are not elevated, then maintenance fluids should include potassium chloride (see 2.2).

In very unwell children, e.g., hypovolaemia use sodium chloride 0.9% without glucose, initially for resuscitation (see section 3).

Fluid therapy will need to be adjusted based on subsequent assessment.

To minimise risk of hyponatraemia in children older than 1 month sodium chloride 0.9% + glucose 5% are the recommended commencement IV fluids and initial postoperative fluids. These provide sodium in excess of maintenance requirements; however continuous use of this solution is unlikely to result in hypernatraemia as the excess sodium will be excreted by the kidneys.

Hyponatraemia poses a greater acute danger than hypernatraemia; therefore, solutions with low sodium concentrations should be used with caution. In unwell stressed patients (e.g., meningitis, post-surgical, patients receiving opiates, respiratory problems etc), stress response and elevated antidiuretic hormone (ADH) secretion may result in water retention.

Prescribed maintenance fluids should be reviewed regularly and may need to be adjusted in some children. A typical example is the need to increase maintenance fluids by 10-20 % when fever is present.

2.2 Maintenance Electrolytes and Glucose

Sodium

- **First week of life:** 1 to 1.5 mmol/kg/day
- **2 to 3 months old:** 3 mmol/kg/day
- **2 years old:** 2 mmol/kg/day
- Hyponatraemia may be caused by water overload or salt depletion.
- Water overload is a common cause of hyponatraemia and simply requires water restriction.
- The patient who is salt depleted is usually also water depleted (dehydrated). Slow replacement of sodium depletion with sodium chloride 0.9% is usually all that is required. Rapid correction of the sodium deficit is required only in the rare circumstance of symptomatic hyponatraemia, which may occur at sodium levels below 125 mmol/L. Intravenous hypertonic saline (sodium chloride 3%) is used only in exceptional circumstances and may warrant ICU admission. Hypertonic saline (sodium chloride 3%) should never be used without Intensivist approval. It is highly hyperosmolar, irritant and should be administered via Central Venus Line where possible. **Peripheral administration is to occur in emergency situations only**.

Potassium

- **Usual daily requirement:** Approximately 2 mmol/kg/day
- Severe total body potassium deficit (e.g., Infantile pyloric stenosis and diabetic ketoacidosis): 5 mmol/kg/day of potassium (or more) may be necessary, regardless of the initial serum potassium.
- Standard premixed solutions containing potassium chloride (20 mmol/1000 mL for children over 1 month and 10 mmol/500 mL for neonates) are available throughout the hospital and should be used in the majority of patients except those with hyperkalaemia, renal impairment or significant oliguria. Do not administer potassium-containing fluids until there is urine production and the serum potassium level is known.
- Where additional potassium is added to maintenance fluids: Potassium concentration should not exceed more than 40 mmol/1000 mL without approval of a senior doctor. This is available in a premixed solution with sodium chloride 0.9% + glucose 5%.
- Refer to the SCHN Potassium Management Practice Guideline for prescription and administration requirements.

Glucose

- **Usual requirement Neonate:** Approximately 6-8 mg/kg/minute
- **Older infants and children:** Approximately 4-5 mg/kg/minute
- Most fluid regimen will not meet maintenance glucose requirements. Normal hepatic gluconeogenesis is therefore essential to avoid hypoglycaemia. Glucose 10% at 2 mL/kg/hour provides only 3.3 mg/kg/min, so on the first or second day of life a higher concentration glucose solution may be required to maintain the blood glucose above 2.2 mmol/L. NB: Glucose concentrations >15% should ideally be given via CVL and BSL monitored.

2.3 Monitoring

All dehydrated children or children on full maintenance IV fluids should be weighed prior to the commencement of therapy and at least daily thereafter.

Children on full maintenance IV fluids should have serum electrolytes checked before commencing the infusion and daily thereafter. More frequent electrolyte determination may be required according to individual circumstances and clinical progress.

Make sure that there are clear orders with respect to frequency and type of vital sign monitoring your patient requires and the upper and lower limits of the observations at which medical staff should be called to reassess the child.

3 Elective surgery in a relatively well child

3.1 Preoperative period

Children should have appropriate fasting. If these fasting rules are applied, no supplemental intravenous fluids should be required in the pre-operative period for well infants and children. This also applies to many children having urgent surgery, where abnormal fluid losses have not yet occurred.

An unwell dehydrated patient will need appropriate resuscitation and rehydration pre-operatively.

See the respective guideline for additional information:

- **At SCH**
  - Preoperative Oral Fluids – SCH
  - Type 1 Diabetes Mellitus in Children During Surgery and Fasting – SCH
- **At CHW**
  - Fasting Guideline for Children Having General Anaesthesia – CHW
  - Fasting and Surgery - Type 1 Diabetes Mellitus (T1DM) – CHW

3.2 Intraoperative

Maintenance fluid may be continued as per this guideline. All acute and ongoing fluid losses must be replaced with appropriate fluids (sodium chloride 0.9%, Hartmann's, colloids or blood products) according to the individual anaesthetist's decision. Glucose containing solutions should never be used for rapid volume replacement.

3.3 Postoperative period

Stress response to surgery often results in non-osmotic ADH secretion, increased water retention and a tendency towards hyperglycaemia. Also, many children are relatively salt and water over-hydrated at the completion of surgery due to the volume of intravenous fluids given to counter the vasodilatation caused by general anaesthetic medications and regional anaesthesia. Fluids containing low concentrations of sodium chloride should be used with caution in the immediate post-operative period (first day).

In children:

- less than one month of age, use sodium chloride 0.45% + glucose 10%
- one month or older, use sodium chloride 0.9% + glucose 5%.

Each of these fluids should be given at reduced maintenance (approximately 80%) in the first 24 hours. Ongoing losses must also be replaced.

Supplemental potassium is usually not necessary in the first 24 hours and should not be commenced until urine is passed and a serum potassium level has been checked.

Re-evaluate the child's fluid requirements within 8 hours of initiation or change in fluid orders.

4 Unwell Medical or Surgical patients

Unwell children should be managed according to the following:

1. Treat SHOCK / HYPOVOLAEMIA
2. Replace DEFICIT / DEHYDRATION
3. Replace ONGOING LOSSES
4. Provide MAINTENANCE REQUIREMENT
5. Re-evaluate OFTEN

1. Clinically significant Shock/Hypovolaemia

i. Treat neonates with 10 mL/kg 0.9% sodium chloride IV then reassess

ii. Treat children with 20 mL/kg 0.9% sodium chloride IV rapidly then reassess; repeat if necessary. Exercise caution in children with suspected raised intracranial pressure, diabetic ketoacidosis or meningitis. Isotonic crystalloid solutions such as Hartmann's or Plasma-Lyte 148 may be administered as advised by the Specialist.

iii. If the child requires more than 40 mL/kg of fluid resuscitation, consider blood and operative management in trauma, and inotropes (± ventilatory support) in sepsis. Consult with on-call Intensivist.

Do not include this fluid volume in any subsequent calculations.

2. Clinical Assessment of Deficit/Dehydration

DEFICIT: A child's fluid deficit in millilitres (mL) can be calculated following an estimation of the degree of dehydration expressed as percentage (%) of body weight.

Fluid deficit (mL) = wt (kg) x percent (%) dehydration x 10

Percent (%) Deficit/Dehydration	Symptoms and Signs
3%	Reduced urine output
5%	Tachycardia, reduced skin turgor
7%	Marked reduction skin turgor, reduced fontanelle tension, lassitude and/or restlessness
10%	Shock, marked tachycardia, prolonged capillary refill +/- hypotension

Note: Hypotension in children is a late and potentially preterminal sign.

Precise calculation of fluid deficit due to dehydration using clinical signs is often inaccurate. The best method relies on the difference between the current body weight and the immediate pre-morbid weight. *Prompt fluid resuscitation should take priority in patients with any clinical signs of shock.* Once there has been correction of hypovolaemia, further deficit should be replaced over the next 24 hours in most circumstances.

Example calculation of fluid deficit (for 24 hours)

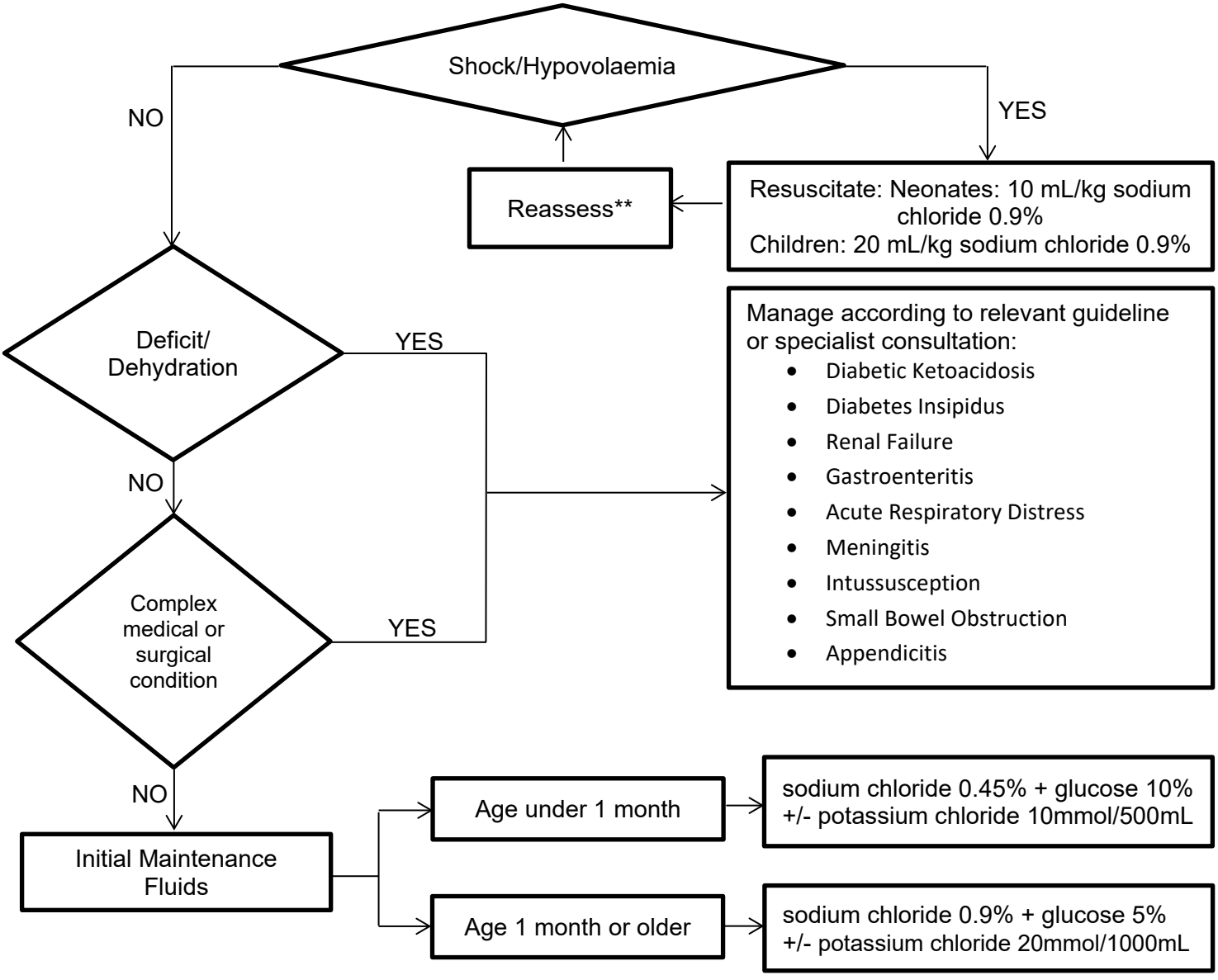
Child with dehydration: weight 22kg, estimated dehydration 5%

Maintenance (22kg):	1000+500+40	= 1540mL
Deficit (5%):	22 kg x 5% x10	= 1100mL
Total fluid requirement:	1540 + 1100	= 2640ml/24 hours or 110mL/h

3. Ongoing losses (e.g., from drains, vomiting, diarrhoea)

These are best measured and replaced. Calculations may be based on each previous hour, or each 4-hour period. For upper GIT losses use sodium chloride 0.9% + glucose 5% + potassium chloride 20 mmol/1000 mL.

5 Intravenous Fluids Flowchart



**If patient remains shocked after 40 mL/kg fluid consult with Intensivist on-call

Do not add potassium until there is urine production and serum potassium level is known.

Children on full maintenance IV fluids should have serum electrolytes checked before commencing the infusion and **daily** thereafter. Those with severe electrolyte derangement may require more frequent sampling during the first 24 hours.

Neonates should have blood glucose level checked initially and then 8 hourly when on maintenance fluids.

*Isotonic crystalloid solutions such as Hartmann's or Plasma-Lyte 148 + glucose 5% may be administered under direction of a Specialist.

6 References

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4. Saba T, Fairbairn J, Houghton F, Laforte D, Foster B, A randomized controlled trial of isotonic versus hypotonic maintenance intravenous fluids in hospitalized children, BMC Pediatrics 2011, 11:82
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8. Paediatric Improvement Collaborative (PIC) Clinical Practice Guideline Neonatal Intravenous Fluids (Oct 2020): https://www.rch.org.au/clinicalguide/guideline_index/Neonatal_intravenous_fluids/ (accessed 2/7/24)