

## Document Control

|   |                    |  |  |
|---|--------------------|--|--|
| <b>Title</b>  |                    |  |  |
| <b>Paediatric IV Fluid Guideline</b>  |                    |  |  |
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| <ul style="list-style-type: none"> <li>• Consultant Paediatricians</li> <li>• Lead Surgeon</li> <li>• Lead Anaesthetist</li> <li>• Emergency Department Lead</li> <li>• Paediatric Pharmacist</li> <li>• Lead Paediatric Nurse</li> </ul> |                    | Paediatric Clinical Audit & Effectiveness<br>Lead or Lead Clinician                                    |  |
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## 1. Introduction

This document sets out Northern Devon Healthcare NHS Trust's policy for Paediatric Infusions. It provides a robust framework to ensure a consistent approach across the whole organisation, and supports our statutory duties as set out in the NHS Constitution.

## 2. Purpose

The purpose of this document is to ensure adherence to best practice and relevant patient safety alerts, rapid response reports, guidelines and recommendations from the National Patient Safety Agency (NHS Commissioning Board Special Health Authority from June 2012), Medicines and Healthcare Products Regulatory Agency and National Institute for Health and Clinical Excellence, with updates to be applied as required.

The policy applies to all Trust clinical staff managing children or neonates.

Implementation of this policy will ensure that:

- Intravenous fluids & infusions are safely administered to children & neonates
- The risk of iatrogenic hyponatraemia is minimised

## 3. Responsibilities

### 3.1 Role of prescribing clinician

The prescribing clinician is responsible for:

- Ensuring that infusions are prescribed on a standard Trust prescription chart
- Ensuring that the correct type of fluid, dose of drug, rate and volume is prescribed for the right patient, with reference to the Trust's [Medicines Policy](#), [Trust Formulary](#), current British National Formulary for Children, or other reference, as appropriate.

### 3.2 Role of Registered Nurse or other Registered Professional

The Registered Nurse or other Registered Professional is responsible for:

- Ensuring that the infusion is correctly administered to the correct patient as prescribed.
- Ensuring that the infusion volume to be infused and rate or duration are cross checked at the pump by a second registered professional
- Ensuring that the infusion pump or syringe driver, administration set, cannulation site and patient are checked at least every hour

## 4. Patients

All neonates, children and adolescents with the exception of neonates on NICU/SCBU, burns patients, metabolic patients, diabetes insipidus, diabetic ketoacidosis (DKA), patients at risk of tumour lysis or on specific chemotherapy hydration regimes, pyloric stenosis patients and metabolic patients.

## 5. Background

This document acts as the main fluid guideline document for all full term neonates, children and adolescents being treated by North Devon District Hospital with the exception of paediatric burns, diabetic ketoacidosis (DKA), newly diagnosed diabetes insipidus patients, Neonates on SCBU/NICU, Metabolic patients, pyloric stenosis patients and patients at risk of tumour lysis or on specific chemotherapy hydration regimes, for whom separate guidelines exists.

These guidelines are written to ensure that the hospital is compliant with NICE guidelines on Intravenous fluid therapy in children and young people (NG29) published December 2015 and the previous NPSA alert 22 on reducing the risk of hyponatraemia when administering intravenous infusions to children.

<https://www.nice.org.uk/guidance/ng29>

## 6. Some Useful Definitions

### **Tonicity**

Tonicity is a property of a solution with reference to a membrane. It is the effective osmolality of a solution and is equal to the sum on concentrations of solutes that have the capacity to exert an osmotic force across a semi-permeable membrane. For example, Glucose 5% is initially isosmolar with plasma but, in normal conditions glucose is a permanent and ineffective solute which readily enters cells. Glucose 5% is therefore isosmolar with plasma but hypotonic with reference to the cell membrane (see appendix 1) i.e. glucose does not contribute to the relative tonicity. Care should be exercised when interpreting the references to solution tonicity.

### **Osmolality**

Osmolality is the property of a solution independent of any membrane. It is the number of osmoles of solute per kilogram of solvent. Osmolality is a measure of the number of particles present in a solution and is independent of the size or weight of the particles.

### **Osmolarity**

Osmolarity is the number of osmoles per litre of solution

### **Osmole**

One osmole equals the molecular weight of a substance in grams divided by the number of freely moving particles each molecule liberates in solution

## 7. General Principles of Fluid Prescribing

- Only use IV fluid for patients whose needs cannot be met by oral or enteral routes
- Assess and manage patients fluid and electrolyte needs at least daily (unless patient long term and stable)
- When prescribing IV fluids remember the 5 fluid R's: Resuscitation, Routine maintenance, Replacement, Redistribution and Reassessment.
- IV fluid prescriptions must include the type of fluid, the rate and the volume to be administered
- Patients should have an IV fluid management plan which must include details of the fluid and electrolyte need, the assessment and monitoring required over the next 24 hours
- When prescribing fluids ensure you take into account fluids that the patient is receiving from other sources such as oral, enteral, nutrition and medication.
- Patients can contribute to their own fluid management. Clinical staff should have discussed with them the need for the fluid, and the signs and symptoms that they should keep an eye out for if their fluid balance needs adjusting. If asked ensure that patients and /or their carers have access to NICE's information for the public leaflet about fluid use in children.

<https://www.nice.org.uk/guidance/ng29/resources/intravenous-fluid-therapy-in-children-and-young-people-in-hospital-pdf-2838599703493>

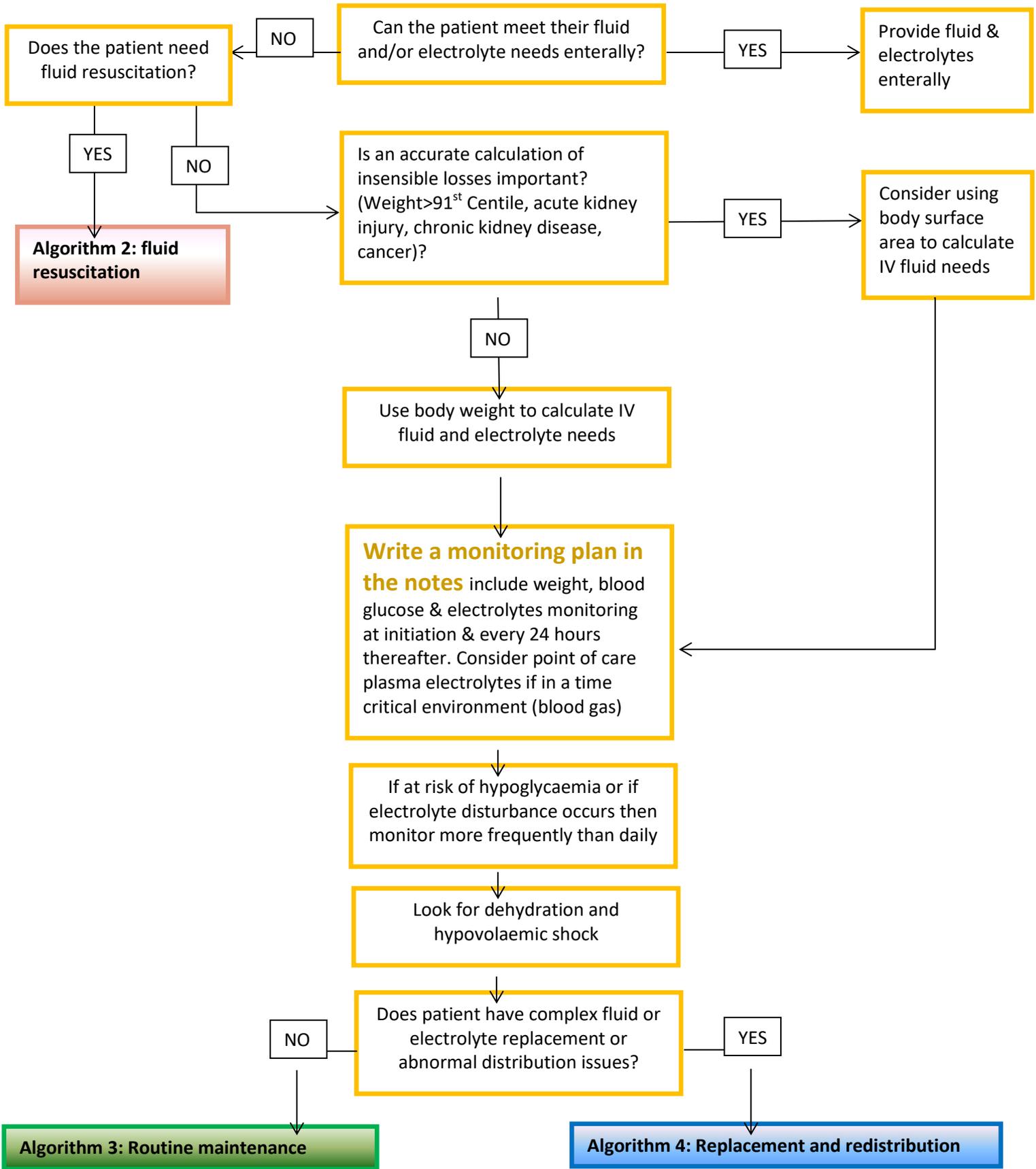
## 8. Monitoring Principles

- Ongoing losses should be assessed every 4 hours and replaced with fluid containing electrolytes mirroring the electrolyte content of the lost fluid
- Fluid Balance measuring & documentation should be undertaken in unwell patients on IV fluids
- Measuring of serum **Sodium, Potassium, Urea and Creatinine** should occur at baseline and then **daily** or every 4-6 hours where there are significant abnormalities.
- Weight should be checked daily for all patients on IV fluids.
- Urinary chemistry may be useful in some cases

## 9. Guideline Algorithms

- 9.1. Algorithm 1: Assessment and Monitoring
- 9.2. Algorithm 2: Fluid Resuscitation
- 9.3. Algorithm 3: Routine Maintenance for Children & Term Neonates
- 9.4. Algorithm 4: Fluid Replacement & Redistribution
- 9.5. Algorithm 5: Managing Hypernatraemia
- 9.6. Algorithm 6: Managing Hyponatraemia

**Algorithm 1: Assessment and monitoring**



**Algorithm 2: Fluid Resuscitation**

Does the patient have a pre-existing condition (eg cardiac, kidney disease)?

NO

YES

Take into account pre-existing conditions as smaller fluid volumes may be needed.

**Give PlasmaLyte or 0.9% Sodium chloride**

Use 20ml/kg over less than 10 minutes for children and young people **or** 10-20ml/kg over less than 10 minutes for term neonates.

Reassess after bolus complete

If further bolus' needed then inform consultant

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.

**Algorithm 3: Routine maintenance for children and term neonates**

Measure plasma electrolytes concentrations, blood glucose & weight when starting IV fluids & **at least** every 24 hours thereafter.

For children <10kg monitor blood glucose 6 hourly.

**A monitoring plan covering these aspects must be written in the notes**

Is an accurate calculation of insensible losses important?  
e.g. AKI or weight above 91st Centile?

YES

Consider using Body surface area to calculate fluids.

NO

Use body weight to calculate IV fluid needs

Calculate routine maintenance IV fluid rates for children and young people using the Holliday-Segar formula:

- 100ml/kg/day for the first 10kg of weight
- 50ml/kg/day for the second 10kg of weight
- 20ml/kg/day for the weight over 20kg

For children >40kg the fluid will normally be capped at a maximum of 2000ml/day

For newborn neonates in first days of life fluid increases stepwise during the first 3 days from 60ml/kg to 90ml/kg and then cap at 100ml/kg on day 3

**Prescribe fluid as PlasmaLyte with 5% glucose**

Exceptions

- Patients at risk of high blood sugars e.g. those on high dose steroids use plasmalyte
- For newborn neonates in critical postnatal adaptation phase (e.g. respiratory distress syndrome, meconium aspiration, hypoxic ischaemic encephalopathy), give no or low sodium fluids e.g. Glucose 10% until postnatal diuresis with weight loss occurs

Is the patient at risk of SIADH (Syndrome of inappropriate Antidiuretic hormone secretion) e.g. acute respiratory illness, meningitis or postoperative?

NO

YES

Consider restricting to 80% of routine maintenance.

Review IV fluid prescription based on plasma electrolyte concentrations & blood glucose results at least every 24 hours.

For children <10kg (particularly neonates) monitor blood glucose 6 hourly as higher concentrations of glucose may be needed to keep blood sugar above 3mmol/L.

Measure weight daily but only change fluid prescription if weight change significant.

## Maintenance fluid calculators

To assist prescribers in the calculation of maintenance fluid calculations there are a variety of calculator tools available. Take care to select the right one dependant on the need of your patient.

1. **Well child** maintenance fluid calculator (not suitable for neonates in first 2 days of life)  
<http://www.avon.nhs.uk/dms/Download.aspx?r=1&did=7983&f=MaintenanceFluidCalculatorForChildren-3.xls>

### 2. **Acute respiratory illness**

Maintenance fluid calculator for patients with respiratory illnesses (pneumonia, asthma or bronchiolitis). Due to inappropriate ADH secretion they have increased fluid retention & therefore require maintenance fluid which is approximately 80% that of a well child  
<http://www.avon.nhs.uk/dms/Download.aspx?r=1&did=7984&f=AcuteRespiratoryIllnessMaintenanceFluidCalculatorF-3.xls>

### 3. **Meningitis**

The prescribed maintenance fluids in children with meningitis should be 60% of the maintenance fluids of a well-child. This is due to SIADH as well as the importance of preventing hyponatraemia and the resulting cerebral oedema.

### 4. **Post-operative days 1&2.**

Although post-operative patients often have ongoing losses that need to be closely monitored and replaced they require less maintenance fluid due to elevated levels of ADH secondary to pain stress and opiates. Their maintenance should be restricted to 80% of maintenance fluids during the first 1-2 days then return to full maintenance thereafter

## Notes on adapting maintenance for HDU/PICU patients

- Ventilated (non-cardiac) patients

“Normal” maintenance fluids for a child on a ventilator would be 80% unless insensible losses are very high (i.e. diarrhoea or profuse sweating).

- Suspected raised intracranial pressure

Initially fluids should be severely restricted to 50-60% serum sodium must be carefully monitored and not allowed to drop.

**Algorithm 4: Fluid Replacement and Redistribution**

Adjust the IV fluid prescription to account for existing fluid and /or electrolyte deficits or excesses, ongoing losses or abnormal distribution

**Consider using PlasmaLyte for redistribution**

Need to replace ongoing losses?

NO

YES

**Use 500ml 0.9% sodium chloride with 10 or 20mmol potassium**

Ongoing losses should be replaced every 4 hours with the losses of the previous 4 hours replaced over the next 4 hours.

Base subsequent fluid composition on plasma electrolyte concentrations and blood glucose measurements

## Deficit fluid

A child's water deficit in ml can be calculated after the degree of dehydration has been expressed as a percentage of the body weight

### **Total Deficit Volume to be replaced = weight x % dehydration x 10**

(e.g. 12kg child whom is 5% dehydrated requires  $12 \times 5 \times 10 = 600\text{ml}$  over 24 hours)  
Replacement should be over 24 hours in most cases of gastroenteritis but slower in diabetic ketoacidosis (see DKA guidance), meningitis and hypernatremia (48-72 hours). Sodium should not be allowed to fall by more than 0.5mmol/litre/hour (12mmol/L per 24 hours)

The best estimation of dehydration is the difference between the child's immediate pre-morbid weight and the current weight but if this is not available then clinical signs should be used.

The most common clinical signs used in the estimation of dehydration are

- Cool peripheries with prolonged capillary refill time
- Decreased skin Turgor (beware hypernatraemic dehydration)
- Dry mucosal membranes
- Sunken eyes
- Sunken fontanelle
- Irritability and lethargy
- Deep (Kussmauls) breathing (secondary to metabolic acidosis)
- Increased thirst

Depending on the degree of and number of these signs present the child can be placed in one of three categories

- Mild or No dehydration (<5% dehydrated) No clinical signs
- Moderate dehydration (5-10% dehydrated) some physical signs
- Severe dehydration (>10% dehydrated) multiple signs +/- acidosis & hypotension

## Ongoing losses

Ongoing losses should be assessed every 4 hours and the fluids used to replace the ongoing losses should reflect the electrolyte composition of the fluid being lost. The losses of the preceding 4 hours should be replaced over the following 4 hours

<https://www.nice.org.uk/guidance/ng29/resources/diagram-of-ongoing-losses-for-children-and-young-people-pdf-2190276253>

## Insensible Losses

Estimate insensible losses within the range 300--400 ml/m<sup>2</sup>/24 hours plus urinary output.

**Algorithm 5: Managing Hyponatraemia**  
(plasma sodium more than 145mmol/L) that develops during IV fluid therapy

If hyponatraemia develops review the fluid status

NO

Fluid status uncertain?

YES

Measure urine sodium and osmolarity

Evidence of dehydration?

NO

YES

If using an isotonic solution **consider changing to hypotonic by prescribing 0.45% Sodium chloride +/- 5% glucose +/- potassium**

Calculate the water deficit and replace it over 48 hours initially with **0.9% Sodium chloride +/- 5% glucose +/- potassium**

Ensure the rate of fall of plasma sodium does not exceed 12mmol/L in a 24 hour period

YES

Hyponatremia worsening or unresponsive?

NO

Measure plasma electrolyte concentrations every 4-6hours for the first 24hours, and after this, base the frequency of further plasma electrolyte measurements on the treatment response.

**Algorithm 6: Managing Hyponatraemia**  
(plasma sodium less than 135mmol/L) that develops during IV fluid therapy

Does the patient have hyponatraemia symptoms?

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

NO

If the child is prescribed a hypotonic fluid change to an isotonic fluid (e.g. PlasmaLyte +/- glucose)

If hypervolaemic or at risk of hypervolaemia, restrict maintenance IV fluids 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 300-400ml/m<sup>2</sup>/24 hours plus urinary output

YES

Seek immediate expert advice (e.g. from PICU)

**Consider a bolus of 2ml/kg (max 100ml) of 2.7% sodium chloride over 10-15minutes**

Symptoms still present after bolus?

YES

**Consider second bolus of 2ml/kg (max 100ml) of 2.7% sodium chloride over 10-15minutes**

Symptoms still present after second bolus?

YES

Check Plasma sodium level and **consider a third bolus of 2ml/kg (max 100ml) of 2.7% sodium chloride over 10-15minutes**

NO

NO

Measure plasma sodium levels at least hourly then as symptoms resolve, decrease frequency of measurement according to response. **Insure that the rate of plasma sodium increase does not exceed 12 mmol/Litre in 24 hours**

**Appendix 1**

## Constituents of PlasmaLyte and other base fluids

| Fluid                                 | Sodium mmol/L | Potassium mmol/L | Magnesium mmol/L | Chloride mmol/L | Acetate mmol/L | Gluconate mmol/L | Osmolality mOsmol/L | Osmolarity compared to plasma | Tonicity compared to membrane |
|---------------------------------------|---------------|------------------|------------------|-----------------|----------------|------------------|---------------------|-------------------------------|-------------------------------|
| PlasmaLyte                            | 140           | 5                | 1.5              | 98              | 27             | 23               | 295                 | Isosmolar                     | Isotonic                      |
| PlasmaLyte + 5% dex                   | 140           | 5                | 1.5              | 98              | 27             | 23               | 573                 | Hyperosmolar                  | Isotonic                      |
| 0.9% Sodium Chloride                  | 154           | 0                | 0                | 154             | 0              | 0                | 308                 | Isosmolar                     | Isotonic                      |
| 0.9% sodium chloride + 5% dex         | 154           | 0                | 0                | 154             | 0              | 0                | 585                 | Hyperosmolar                  | Isotonic                      |
| 0.45% Sodium chloride                 | 77            | 0                | 0                | 77              | 0              | 0                | 154                 | Hyposmolar                    | Hypotonic                     |
| 5% dextrose                           | 0             | 0                | 0                | 0               | 0              | 0                | 278                 | Isosmolar                     | Hypotonic                     |
| 10% dextrose                          | 0             | 0                | 0                | 0               | 0              | 0                | 555                 | Hyperosmolar                  | Hypotonic                     |
| 2.5% dextrose + sodium chloride 0.45% | 77            | 0                | 0                | 77              | 0              | 0                | 293                 | Isosmolar                     | Hypotonic                     |

**SAFETY**

NPSA alert 22 on reducing the risk of hyponatraemia when administering intravenous infusions to children states that hyponatraemic 0.18% sodium chloride should not be routinely stored on paediatric wards or used in paediatric patients due to the inherent risk of it causing hyponatraemia in these patients. Locally the need to use this fluid should be extremely rare and it should not ever be required outside of renal areas or critical care areas.

Guideline adapted from Intravenous fluid therapy in children and young people in hospital, NICE guideline [NG29] Published date: 09 December 2015 Last updated: 11 June 2020

<https://www.nice.org.uk/guidance/ng29>

and Bristol Children's Hospital, Clinical Guideline, Fluid Management in Paediatric Patients, v5.0, May 2020-May 2023.

[http://www.avon.nhs.uk/dms/Download.aspx?r=1&did=7987&f=FluidManagementInPaediatricPatients-5\\_0.pdf](http://www.avon.nhs.uk/dms/Download.aspx?r=1&did=7987&f=FluidManagementInPaediatricPatients-5_0.pdf)

## 10. Monitoring Compliance with & the Effectiveness of the Policy

### Standards/ Key Performance Indicators

10.1. Key performance indicators comprise:

- Nice Neonatal Quality Standards
- NICE 2015, NG29: Intravenous fluid therapy in children and young people in hospital
- The National Patient Safety Agency. Patient Safety Alert 22. Reducing the risk of hyponatraemia when administering intravenous infusions to children, March 2007.
- National Patient Safety Agency Rapid Response Report. Prevention of over infusion of intravenous fluid and medicines in neonates. NPSA/2010/RRR015

### Process for Implementation & Monitoring Compliance & Effectiveness

10.2. Staff are informed of revised documentation. There is an expectation that staff are responsible to keep updated on any improvements to practice and deliver care accordingly.

Line managers are responsible for ensuring this policy is implemented across their area of work.

Support for the implementation of this policy will be provided by the Paediatric and Neonatal Team.

The policy is reviewed every 3 years and the policy may be revised earlier according to new evidence and learning.

10.3. Monitoring process.

Prescription charts are monitored and reviewed by the Paediatric Pharmacists.

Incidents related to the delivery of Intravenous fluids and those related to non-adherence of the policy are monitored by the Trust and Paediatric governance teams. Incidents are reported by the Datix system.

Non-adherence is reviewed and action plans made if required. Discussion and reviews occur at Directorate meetings, Governance meetings and Ward meetings. Learning and action plans are cascaded at these meetings and improvements implemented. Key findings and learning points will be disseminated to relevant staff.

## 11. Equality Impact Assessment

The Trust aims to design and implement services, policies and measures that meet the diverse needs of our service, population and workforce, ensuring that none are placed at a disadvantage over others. An Equality Impact Assessment Screening has been undertaken and there are no adverse or positive impacts.

- 11.1.** The author must include the Equality Impact Assessment Table and identify whether the policy has a positive or negative impact on any of the groups listed. The Author must make comment on how the policy makes this impact.

**Table 1: Equality impact Assessment**

| Group  | Positive Impact | Negative Impact | No Impact | Comment |
|--|-----------------|-----------------|-----------|---------|
| Age  |                 |                 | X         |         |
| Disability   |                 |                 | X         |         |
| Gender   |                 |                 | X         |         |
| Gender Reassignment  |                 |                 | X         |         |
| Human Rights (rights to privacy, dignity, liberty and non-degrading treatment) |                 |                 | X         |         |
| Marriage and civil partnership   |                 |                 | X         |         |
| Pregnancy  |                 |                 | X         |         |
| Maternity and Breastfeeding  |                 |                 | X         |         |
| Race (ethnic origin)   |                 |                 | X         |         |
| Religion (or belief)   |                 |                 | X         |         |
| Sexual Orientation   |                 |                 | X         |         |