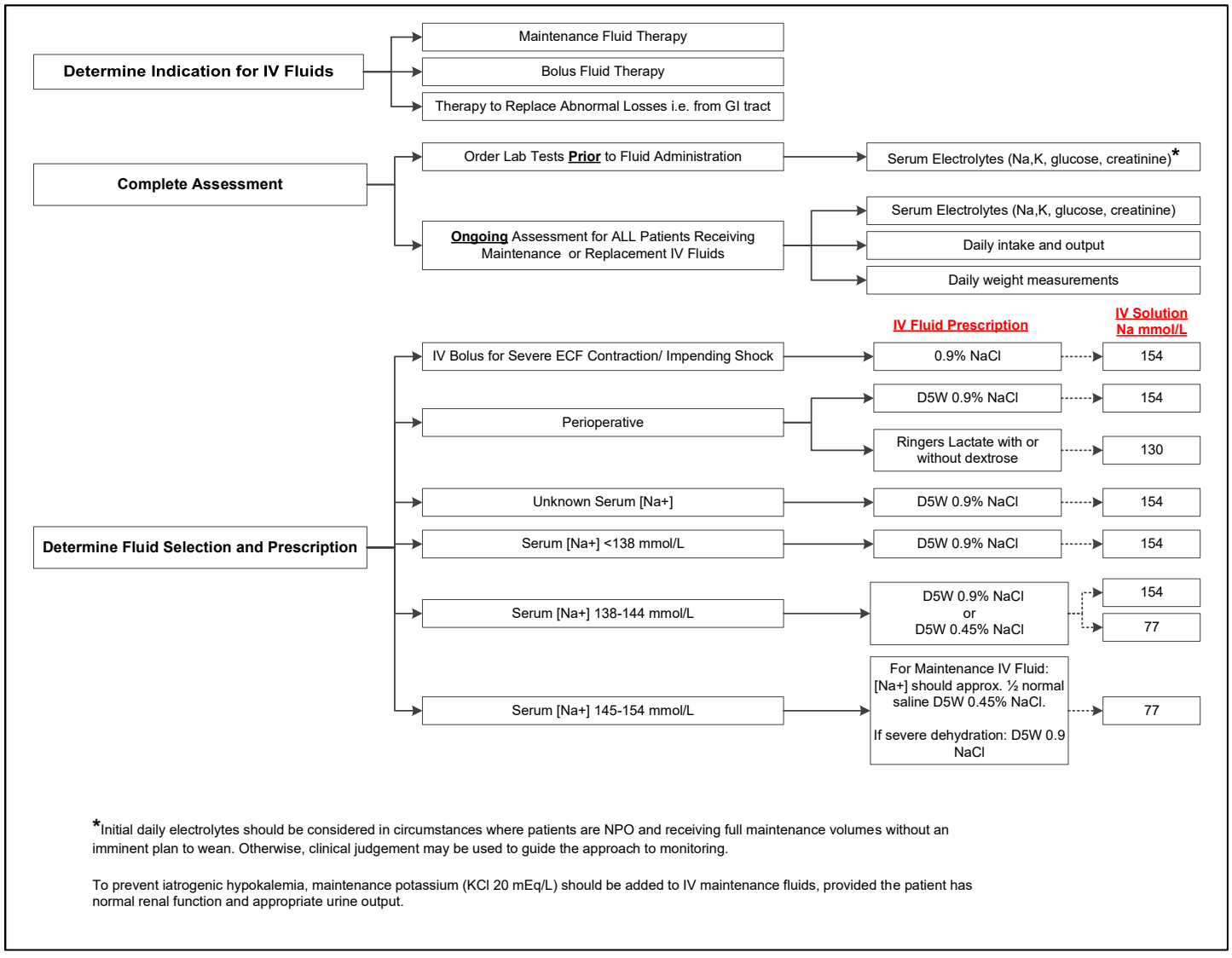
Fluid and Electrolyte Administration in Children

IV Fluid Maintenance in Children: Assessment and Prescribing Recommendations



*Initial daily electrolytes should be considered in circumstances where patients are NPO and receiving full maintenance volumes without an imminent plan to wean. Otherwise, clinical judgement may be used to guide the approach to monitoring.

To prevent iatrogenic hypokalemia, maintenance potassium (KCl 20 mEq/L) should be added to IV maintenance fluids, provided the patient has normal renal function and appropriate urine output.

Introduction

Salt and water homeostasis is frequently abnormal in hospitalized patients. Hyponatremia (Plasma Sodium (PNa) <135 mmol/L) is an imbalance of sodium and water, such that the ratio of free water to sodium is increased. Hypernatremia (PNa >144 mmol/L) is an imbalance of sodium and water, such that the ratio of free water to sodium is decreased.

The purpose of this clinical practice guideline is to facilitate appropriate screening, prescription, and monitoring of intravenous (IV) fluid and electrolyte administration in patients 1 month to 18 years of age admitted to SickKids or treated in the Emergency Department (ED).

Target Patient Population:

- Children 1 month to 18 years.
- **Does not apply** to patients in the neonatal intensive care unit.
- For neonates (<1 month) outside of the NICU setting, insufficient evidence exists for firm recommendations. However, reflecting neonates' unique renal physiology and relative inability to handle sodium load, emerging evidence suggests that isotonic fluids result in a high risk of hypernatremia and may not be appropriate in the first month of life.[1] Pending further study, D5W.0.45% NaCl is recommended in this population. Attention should be paid to appropriate total fluid volume for age, and careful electrolyte monitoring.

Target Users:

- Physicians, nurses, and paramedics.

Definitions

- **Acute hyponatremia:** defined as a rapid fall in serum sodium from a normal level to <135 mmol/L within 48 hours. This can result in acute cerebral edema and brain stem herniation and has been associated with the administration of intravenous (IV) hypotonic fluids in children, particularly in the perioperative period. These patients may retain free water due to non-physiological secretion of anti-diuretic hormone (ADH). The use of isotonic fluids, which contain no electrolyte free water, will mitigate this risk.
- Please refer to page 6 of this guideline for further information about diagnosis and management of acute hyponatremia

Definition	Serum [Na+] mmol/L
Normal/reference range	135 - 144
Acute Hyponatremia	Reduction in Na to <135 mmol/L within 48 hr
Hypernatremia	>144

Recommendations

- This guideline should be followed when prescribing IV maintenance fluids. Recommendations on the type of solution to be used for fluid bolus therapy are also included.

Indications for prescribing IV fluids in pediatric patients

1. Maintenance fluid therapy to replace estimated normal physiologic urine output and insensible losses in patients with reduced or no oral intake.
2. Bolus fluid therapy to expand the circulating volume in children with hypovolemia or shock.
3. Replacement fluid therapy to replace abnormal losses from the GI tract or other body cavities. The replacement fluid prescribed should be of the same electrolyte composition as the fluid that is being lost and should also consider the volume depleted.

General principles

- Non-physiological (inappropriate) ADH secretion is stimulated by, for example, pain, vomiting, anxiety, opioids, anesthetic agents, and positive pressure ventilation. Given the non-specific nature of many of these factors, any hospitalized child requiring IV maintenance fluids should be considered at risk. Clinical groups identified in published studies as being particularly vulnerable include children undergoing surgery, in ICU and those with acute illnesses including meningitis, encephalitis, bronchiolitis and pneumonia. While most children will tolerate standard maintenance fluid requirements, some acutely ill children at highest risk for increased ADH secretion may benefit from their maintenance fluids being restricted, based on their clinical status. Usual maintenance requirements should be in the form of isotonic saline.[2, 3]

- Oral fluid intake must be included in the estimation of total fluid intake. Most oral fluids are very hypotonic, i.e., much below the sodium concentration of recommended IV fluids. Both the volume and the concentration of sodium in IV and oral fluids are important contributors to the development of hyponatremia.

- Proprietary enteral fluid preparations and some standard parenteral nutrition (PN) solutions are low in sodium (<40mmol/L) and may be a substantial source of electrolyte free water. Despite this, patients on long term PN who are not acutely ill do not appear to be at increased risk for the development of acute hyponatremia. Standard solutions containing higher amounts of sodium (>60mmol/L) are available to order as required. PN orders may also be customized, with varying sodium amounts based on the clinical needs of the patient.

- Infants and young children have limited glycogen stores. Therefore, saline solutions with added dextrose are required to prevent hypoglycemia and ketosis in those without a source of enteral glucose.[4] In some

children, for example those on a ketogenic diet, the addition of dextrose may not be indicated (please discuss with specialist).

- To prevent iatrogenic hypokalemia, maintenance potassium (KCl 20 mEq/L) should be added to IV maintenance fluids, provided the patient has normal renal function and appropriate urine output.[5]

- Certain medications require adjustment to fluid administration to offset side effects and toxicity. Where such notifications appear when prescribing medications (e.g., Acyclovir), pharmacy recommendations regarding fluid administration should be heeded.

Assessment

- Before starting IV fluids, baseline serum electrolytes and renal function (sodium, potassium, glucose, urea, and creatinine) should be measured.[2, 3] Patients undergoing day surgery where the IV is discontinued at the end of the case do not need their electrolytes measured.

Prescription of IV fluid therapy

- Randomized controlled trials suggest that, compared with hypotonic saline, the use of isotonic saline for maintenance IV fluid requirements is less likely to result in hyponatremia and does not increase the risk of developing hypernatremia.[4, 6-18]

- D5W.0.2% sodium chloride (NaCl), D5W or D10W all contain substantial amounts of electrolyte free water and must not be used as maintenance IV fluids.

    - Patients with a demonstrable free water deficit may require the administration of these very hypotonic solutions. The use of these fluids is restricted to the PICU, CCU, NICU, and Nephrology services.

    - Obtain consultation from Nephrology if these solutions are being considered.

- Until serum electrolyte values are known, when starting IV maintenance fluids, D5W.0.9% NaCl is recommended.[2, 3] *Adjust the IV solution as needed when serum electrolyte results become available.*
- Serum sodium < 138 mmol/L → D5W.0.9% NaCl, should be prescribed.[2] When correcting hyponatremia, ensure that the rate of rise of plasma sodium does not exceed 8-10 mmol/L in a 24-hour period.
- Serum sodium 138-144 mmol/L→ IV fluids should contain a minimum sodium concentration of 77mmol/L (D5W.0.9% NaCl or D5W.0.45% NaCl).[2, 16]

- Serum sodium 145-154 mmol/L → IV fluid sodium concentration should approximate one half normal saline (D5W.0.45% NaCl). If severe dehydration is present, D5W.0.9 NaCl may initially be more appropriate. When correcting hypernatremia, ensure that the rate of fall of plasma sodium does not exceed 12 mmol/L in a 24-hour period.[3]
- If hypernatremia is due to salt gain → may receive hypotonic fluids such as D5W.0.2% NaCl (in an ICU setting or in consultation with Nephrology)

    - Patients with (PNa > 154 mmol/L) have either a free water loss or salt gain (i.e., the use of solutions with a high sodium concentration).
    - Infants and young children with severe hypernatremia, most commonly due to free water loss, are at risk for the development of cerebral edema with rapid rehydration when hypotonic saline is used.
    - The water deficit should be replaced slowly, initially with isotonic saline, and frequent electrolyte monitoring, in consultation with nephrology.[3]

Postoperatively

- Isotonic fluids should be used in the perioperative period.[7,13,14,19]
- Dextrose should be added to maintenance fluids for children with no other source of glucose.[4]
- If a decision is made to use maintenance IV fluids without dextrose, then frequent monitoring of the child's blood glucose is required to detect early hypoglycemia.
- Frequency of glucose monitoring will depend on the child's age, size, and underlying diagnosis.
- In the absence of the need to continue with IV fluids for the replacement of ongoing losses, the IV should be discontinued or reduced to a minimum rate, and patients encouraged to take enteral fluids.

Bolus therapy

- IV fluid boluses should be used in children with significant hypovolemia or impending shock and only in the form of isotonic saline (0.9% NaCl).[2,3]

Replacement therapy

- IV fluid therapy to replace losses from the GI tract should match the electrolyte composition of the lost fluid and usually be in the form of isotonic saline with KCl (0.9% NaCl plus KCl 20mEq/L).[3]

Monitoring

- Patients receiving maintenance fluids by the IV route should have measurements of serum electrolytes and glucose regularly. Initial daily electrolytes should be considered in circumstances where patients are NPO and receiving full maintenance volumes without an imminent plan to wean. Otherwise, clinical judgement may be used to guide the approach to monitoring.[2]

- All children receiving IV fluids must have an accurate intake and output record kept which is totaled and assessed at least every 12 hours. Whenever feasible, daily weights should be measured.
- If a maintenance IV fluid without dextrose is used, then frequent monitoring of the child's blood glucose is required.

Diagnosis and treatment of acute symptomatic hyponatremia

- ***Acute symptomatic hyponatremia is a medical emergency and requires rapid and aggressive treatment to prevent the progression to seizures, apnea, and brain stem herniation, resulting from cerebral edema.***

Diagnosis:

- Acute hyponatremia should be suspected when there is headache, nausea, vomiting, confusion, or other new neurologic symptoms in patients receiving hypotonic IV fluids.
- Common features suggesting the progression of cerebral edema due to hyponatremia include seizures, lethargy, and diminished level of consciousness or coma.
- Most cases in children have been reported when the PNa level has fallen from normal to <125 mmol/L within 48 hours, but cerebral edema can occur at higher sodium levels.

Management:

- Send STAT electrolytes
- Begin acute partial correction of the hyponatremia by discontinuing the IV fluid being administered and rapidly administering 3 mL/kg of 3% NaCl (with the goal of increasing the sodium acutely by ~4-5 mEq). This can be repeated once if symptoms are ongoing, followed by a repeat check of electrolytes.
- Anti-epileptic management if applicable
- Notify the PICU and Critical Care Response Team (CCRT).

Related Documents

- Friedman JN. CPS Acute Care Committee. Risk of acute hyponatremia in hospitalized children and youth receiving maintenance intravenous fluids. *Canadian Pediatric Society. December 2018, updated May 2021.* https://www.cps.ca/en/documents/position/acute-hyponatremia-in-hospitalized-children-and-youth
- NICE (2015, updated June 2020). *Intravenous Fluid Therapy in Children and Young People in Hospital*. https://www.nice.org.uk/guidance/NG29

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Reviewers were selected to reflect different backgrounds and perspectives. Their comments and suggestions were considered and the document amended accordingly.

Attachments:

IV fluid pathway_2022 update_FINAL.pdf