

ISMP Canada Safety Bulletin

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Reducing the Risk of Hospital-Acquired Hyponatremia: Intravenous Fluid Management and Monitoring

In 2015, ISMP Canada published an analysis of reports of harmful incidents resulting in hospital-acquired hyponatremia.¹ That multi-incident analysis revealed 2 main causes: incorrect intravenous (IV) solution prescribed and incorrect amount of IV solution infused. Contributing factors included knowledge and monitoring deficits. Since the 2015 bulletin appeared, recognition of the potential for harm from fluid therapy has increased, and efforts have been undertaken to increase awareness and institute strategies to reduce poor outcomes related to hospital-acquired hyponatremia.²⁻⁵ This bulletin reviews recent hyponatremia-related incidents, highlights encouraging findings, refreshes knowledge

about IV fluid management, and incorporates guidance to reduce the risk of hospital-acquired hyponatremia.

INCIDENT EXAMPLES

Incident reports associated with a potential risk of hospital-acquired hyponatremia for a recent 5-year period were extracted from the Canadian Institute for Health Information’s National System for Incident Reporting.*

The majority of reports described incidents related to the inadvertent selection and administration of IV fluids as displayed in Table 1.

TABLE 1. Examples of reported selection and administration errors of IV fluid.

Prescribed Fluid	Fluid Selected and Administered in Error
D5W NS	D5W ½ NS
NS (to correct a low sodium level)	½ NS
NS with 20 mmol/L KCl	D5W ½ NS with 20 mmol/L KCl
D5W NS with 20 mmol/L KCl	D5W ½ NS with 20 mmol/L KCl
D5W NS	D5W
D5W NS with 20 mmol/L KCl	D5W with 20 mmol/L KCl
NS (to correct a low sodium level)	Ringer’s lactate
Ringer’s lactate	2/3 and 1/3 (3.3% dextrose with 0.3% sodium chloride)

D5W represents dextrose 5% in water; NS represents normal saline (0.9% sodium chloride); KCl represents potassium chloride.

* The National System for Incident Reporting (NSIR) is administered by the Canadian Institute for Health Information (CIHI); however, the data analyses, conclusions, opinions, and statements expressed herein are those of ISMP Canada.

The errors were identified by nurses during systematic routine checks (e.g., when changing an empty IV solution bag, at change of nursing shift, or when a patient was transferred from another unit). Although harm was prevented in most cases, one incident described the patient experiencing a decreased level of consciousness, and another incident documented the error as continuing undetected for 3 days.

BACKGROUND

IV fluid therapy is routinely prescribed for acutely ill hospitalized patients. This form of therapy is intended to ensure adequate tissue perfusion, while preserving extracellular fluid volume and a normal electrolyte balance.⁶ However, IV fluid therapy can often lead to hyponatremia, the most common electrolyte disorder among hospitalized patients,² defined as a serum sodium level less than 135 mmol/L.³ The initial symptoms of hyponatremia are vague (Figure 1). Acute hyponatremia, defined as a serum sodium level less than 130 mmol/L developing over a period of less than 48 hours, must be recognized and treated promptly to avoid potentially fatal clinical deterioration.⁵⁻⁷ As serum sodium levels fall, water migrates into the brain cells, causing significant swelling.^{4,8} This can result in decreasing level of consciousness, seizures, and neurological compromise, which can ultimately lead to coma or death.

The authors of a recent article described the complexity of tonicity and osmolality related to IV fluids and advocated for improved labelling of IV fluids.² Tonicity depends on the number and types of constituents in the fluid (e.g., electrolytes, dextrose) and refers to the capability of a solution to cause water to move into or out of a cell, causing the cell to swell or shrink. As a complication in understanding fluid therapy, the tonicity of a fluid can change once the fluid is infused. For example, dextrose is metabolized by the body as it is infused, leaving free water which is hypotonic. Hypotonic fluids (examples given in Table 2) have a lower concentration of electrolytes, mainly sodium, than blood plasma; as such, when they are administered, they can dilute the plasma and reduce serum sodium levels.

Pediatric patients (aged 28 days to 18 years), postoperative patients, and older adults are the populations most at risk of hyponatremia due to use of hypotonic IV fluids.^{2,5,10} Isotonic fluids (examples in Table 2) are generally recommended for these populations.^{5,9,10}

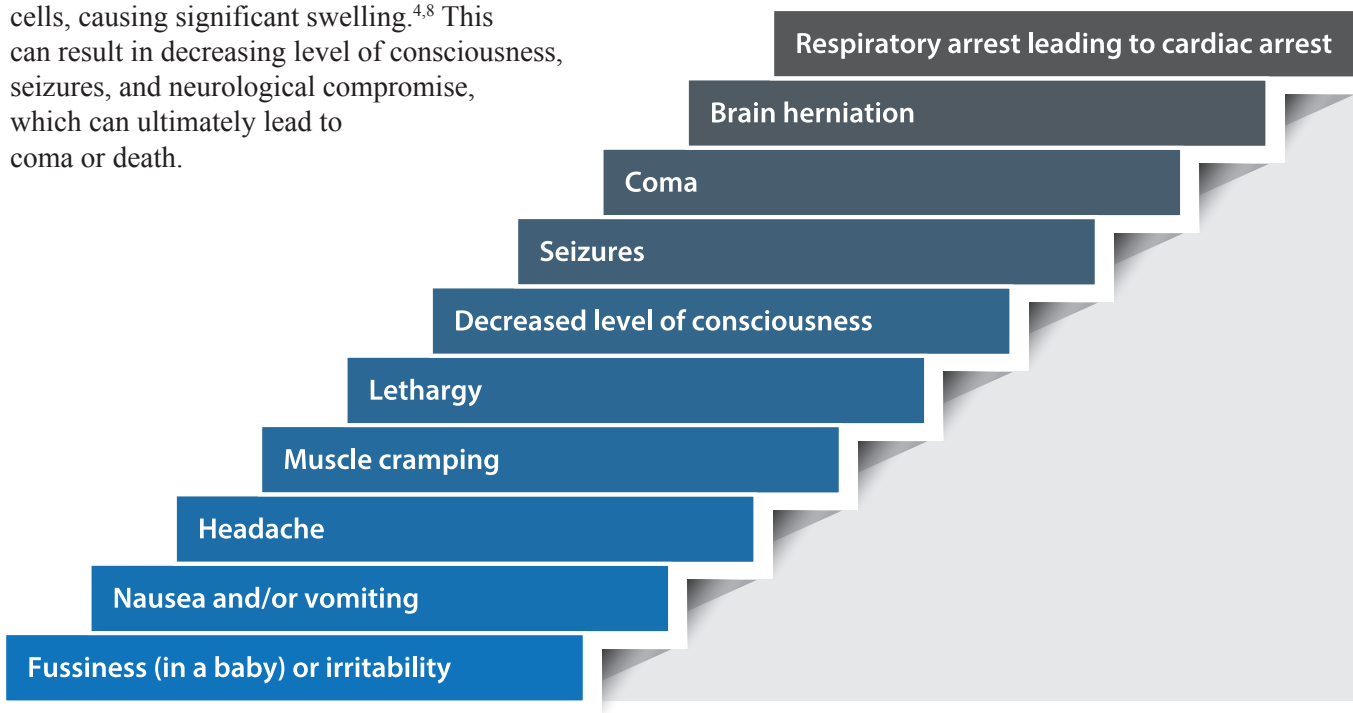


FIGURE 1. Symptomatic progression of untreated acute hyponatremia.^{5,9}

TABLE 2. Examples of fluids for intravenous (IV) administration^{1,2,4,5,9}

Fluid (Colloquial Names)	Sodium Content (mmol/L)	Tonicity
Sodium chloride 0.9% (normal saline, NS)	154	<i>Isotonic</i> Approximates the sodium concentration in blood serum
Ringer's lactate (lactated Ringer's, LR, RL)	130	Often described as <i>isotonic</i> as it contains other constituents (potassium, calcium, lactate); described in some references as <i>slightly hypotonic</i> ^{9,11} May cause or worsen hyponatremia due to a sodium content that is lower than a normal serum sodium level
Dextrose 5% in sodium chloride 0.9% (D5W 0.9% NaCl, D5W NS)	154	<i>Isotonic after infusion</i> , as the glucose is metabolized
Sodium chloride 0.45% (½ NS)	77	<i>Hypotonic</i> May cause hyponatremia
Dextrose 5% and sodium chloride 0.45% (D5W ½ NS)	77	<i>Hypotonic</i> May cause hyponatremia
Dextrose 3.3% and sodium chloride 0.3% (⅔ and ⅓)	51	<i>Hypotonic</i> May cause hyponatremia
Dextrose 5% in water (D5W)	0	<i>Very hypotonic after infusion</i> , as the glucose is metabolized May cause hyponatremia

DISCUSSION

The following were among the contributing factors described in reports of incidents in which an isotonic fluid was ordered, but a hypotonic IV fluid was given in error:

- incorrect storage of the IV solutions on the IV storage cart (e.g., D5W ½ NS with 20 mmol/L KCl stocked where NS with 20 mmol/L KCl was supposed to be stocked)
- similar appearance of IV bag labels
- IV fluid not included in the medication administration record (MAR)
- delays in the identification of possible symptoms of hyponatremia
- lack of laboratory monitoring that might have identified the incorrect IV solution sooner
- challenges in differentiating symptoms of hyponatremia (e.g., confusion) from other conditions with similar symptoms

Knowledge and monitoring deficits were identified as themes in previous ISMP Canada publications describing reports of pediatric deaths due to hyponatremia and in a multi-incident analysis of incidents of hospital-acquired hyponatremia.^{11,12}

More recently, reports of acetylcysteine errors highlighted symptoms of hyponatremia potentially related to overinfusion of D5W (the fluid used to administer acetylcysteine).¹³

Encouraging findings from the incident reviews included improved recognition of the most appropriate IV fluid treatment according to the patient's clinical status and evidence of an understanding of inappropriate fluids. The detection of errors during routine and systematic nursing checks also suggests that processes put in place for monitoring therapies are able to identify and mitigate risks of fluid-related harms.

Professional organizations and medication safety advocates have been promoting appropriate prescribing of IV fluids and use of systems-based strategies, such as storage and availability restrictions; improved packaging, labelling, and product monographs.^{2,5,9}

Although the current bulletin focuses on hyponatremia, errors with IV fluid products can also cause other electrolyte and fluid abnormalities.

RECOMMENDATIONS

All members of a patient's care team have opportunities to continuously improve IV fluid management and monitoring to reduce risks.

Acute Care Organizations: Quality Improvement and Patient/Medication Safety Teams

- Review reports of incidents resulting or potentially resulting in hyponatremia to identify key contributing factors.
- Consider incorporating an alert for computerized order entry systems about the risk of acute hyponatremia with hypotonic IV fluids when these are used for maintenance therapy,¹⁴ especially in pediatric patients.
- Review the types and quantities of IV solutions needed in clinical areas to reduce risk of selection errors.
 - For example, the Canadian Paediatric Society recommends that hypotonic fluids containing less than ½ NS should not be generally available on pediatric wards.⁵
- Ensure mechanisms are in place to check that the types of IV solutions provided to nursing units are correct (e.g., bar-coding technology support).
- Provide focused education on preventing hyponatremia, including evidence-based recommendations for isotonic maintenance fluids for patient populations at increased risk of acute hyponatremia.
- Engage patients and families in treatment plans, including monitoring parameters and the importance of reporting any signs or symptoms of concern to their care providers.¹³

Prescribers

- Unless treating a clinical condition or a specific fluid or electrolyte disturbance, and provided there are no contraindications, prescribe isotonic IV fluids, to reduce the risk of hyponatremia.¹
 - The Canadian Paediatric Society recommends that D5W 0.9% NaCl (D5W NS) be initiated as the maintenance fluid when serum electrolyte levels are not yet available.⁵ Hypotonic fluids containing less than 0.45% NaCl should not be used for routine maintenance fluid therapy.⁵
 - Both the Canadian Paediatric Society and the American Academy of Pediatrics recommend isotonic fluids for routine maintenance, with the recognition that in certain specific circumstances, hypotonic IV solutions may be used, but only with careful monitoring.^{5,9}
- Ensure regular electrolyte monitoring.
- Regularly review the need for IV fluid therapy. If the patient has adequate oral intake of fluids, medications, nutrients, and calories, consider deprescribing any unneeded IV infusion.
- If acute hyponatremia is identified, avoid overly rapid correction.¹⁵ Harm may occur if sodium levels are corrected too quickly.

Nursing Teams

- Ensure the particular IV fluid and rate of infusion are checked against the MAR and/or nursing care plan at the beginning of each shift. If an error in the IV fluid is discovered, inform the prescriber about the incorrect solution that was given, as well as the amount given and the estimated period over which the wrong fluid was infused. Ask the prescriber if blood work is required.
- Ensure that any IV fluid administered is appropriate for the patient's clinical status.
 - Close monitoring and documentation of vital signs, serum electrolytes, and the patient's volume status (intake and output) are essential in preventing hospital-acquired hyponatremia.¹
 - For the pediatric population, weight should be documented daily.⁵
- Immediately report any critical laboratory results to the most responsible physician (MRP), in accordance with organizational policy/protocol. In

some organizations laboratory staff will also notify the ordering physician or MRP of critical test results. For patients with critical results, perform ongoing assessment and observation for clinical signs and symptoms of acute hyponatremia, with prompt reporting of any deterioration in level of consciousness or clinical status, as changes in level of consciousness and the potential for seizures represent a medical emergency.⁵

- Identify knowledge gaps when analyzing incident reports. Address these gaps during education days, huddles, and staff meetings. Ensure that staff are aware of the warning signs of acute hyponatremia, the population(s) most at risk, and how to proactively monitor for this condition.
- Engage patients, family, or essential care partners whenever they express concerns, as subtle changes may be more readily identified as abnormal by family members than by health care providers; family can be an invaluable source of assessment information.¹² Vague symptoms, such as headache, irritability, confusion, restlessness, nausea and/or vomiting, weakness, or a general feeling of malaise,¹ can be early warning signs of acute hyponatremia.¹
- Together with the care team, reassess the need for ongoing IV therapy every day.

Pharmacy Teams

- Continue to enhance IV fluid monitoring by pharmacists. When hypotonic fluids are prescribed for at-risk patients, confirm a valid indication and monitor electrolyte results.

- Develop processes to proactively flag orders for hypotonic solutions for clinical review.
- Include pharmacy technicians in education sessions about the differences among the various IV fluids and their appropriate use.
- Recognize the complexities related to tonicity and osmolality that occur with prescribed IV solutions and promote knowledge among team members to support checks for the appropriateness of fluid orders related to specific clinical indications.

CONCLUSION

Hospital-acquired hyponatremia continues to be an important risk for hospital inpatients. Promising avenues of work are underway to improve safety. IV fluid selection, electrolyte monitoring, and recognition of the clinical signs and symptoms of hyponatremia remain essential in keeping patients safe. All members of the patient’s care team, including the patients themselves and their families, have important roles in monitoring IV fluid treatment.

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