

ISMP Canada Safety Bulletin

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Knowledge and Monitoring Deficits Contribute to Hospital-Acquired Hyponatremia

Main themes identified in an analysis of hospital-acquired hyponatremia incidents were:

- Incorrect intravenous (IV) solution prescribed
- Incorrect amount of IV solution infused

Key strategies to prevent hospital-acquired hyponatremia include addressing knowledge deficits related to:

- Identifying appropriate IV solutions and volume for infusion for the clinical situation
- Understanding that 0.9% sodium chloride reduces the likelihood of developing hyponatremia
- Ensuring regular electrolyte monitoring
- Adjusting IV fluids based on lab results and other clinical parameters
- Recognizing the signs and symptoms of hyponatremia

Intravenous (IV) administration of fluids may result in underappreciated electrolyte and fluid abnormalities. Hyponatremia, defined as serum sodium less than 135 mmol/L,¹ is one such disturbance. Patient populations particularly at risk include children and post-surgical patients.²

Hospital-acquired hyponatremia is associated with poor outcomes, including higher in-hospital mortality, increased length of stay, and higher likelihood of discharge to a facility relative to discharge home.³ Although the occurrence of hyponatremia is strongly related to the composition of the fluid infused, the potential contribution of

other fluid sources (e.g., oral intake of water or ice chips) or of medications or medical conditions that cause dysregulation of sodium and water, should not be overlooked.³ Proper management of fluid and electrolytes requires appropriate knowledge of the general principles of water and electrolyte physiology (e.g., extracellular volume status, ongoing losses, third spacing), IV fluid composition, individual patient comorbidities (including renal function), and clinical changes anticipated from the IV infusion.^{2,3} This knowledge along with close monitoring of vital signs, serum electrolytes, and patient volume status (intake and output, patient weight), along with physical assessment are essential in preventing hospital-acquired hyponatremia.^{3,4}

ISMP Canada undertook a multi-incident analysis of cases involving hospital-acquired hyponatremia with an outcome of harm or death to better understand these patient safety events. Although this bulletin focuses on hyponatremia, other electrolyte and fluid abnormalities are possible with each IV fluid product, and health care professionals must be vigilant to the array of problems that can occur with IV fluid treatment. This bulletin shares the findings of the analysis, highlighting the major themes and contributing factors and identifying opportunities for system-based improvements.

Methodology

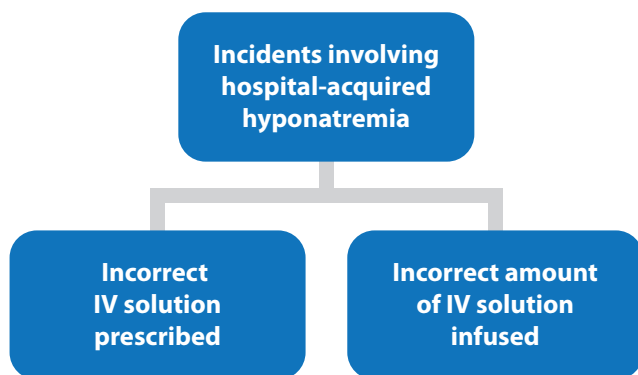
Reports of incidents involving hospital-acquired hyponatremia with an outcome of harm or death were extracted from voluntary reports submitted to ISMP

Canada's incident database from October 1, 2001, to September 30, 2013. Twelve incidents were included in the final analysis which was conducted according to the multi-incident analysis methodology outlined in the Canadian Incident Analysis Framework.⁵

Findings of the Multi-Incident Analysis

The multi-incident analysis revealed two main themes related to the types of errors resulting in hospital-acquired hyponatremia: incorrect IV solution prescribed and incorrect amount of IV solution infused (Figure 1).

Figure 1. Overview of main themes identified in the multi-incident analysis



Main Theme: Incorrect IV Solution Prescribed

The two major contributing factors in the incidents analyzed in this theme were knowledge deficits related to selection of an appropriate fluid to maintain normal serum sodium values and failure to review recent serum sodium values.

Incident example: A previously healthy patient, whose preoperative vital signs and bloodwork results were all within normal limits, was admitted for elective surgery. After an uncomplicated procedure, lactated Ringer's IV solution was ordered, but electrolytes were not measured. After transfer to the floor, the IV solution was changed to dextrose 3.3% and sodium chloride 0.3% (2/3 and 1/3). Later during the stay, the patient reported numbness and weakness of the upper extremities, generalized headache, and a feeling of malaise.

Subsequently, it was noted that the patient's blood pressure was elevated and urine output was reduced. A bolus of 2/3 and 1/3 IV was administered in response. Later, the patient was found unresponsive and experienced a cardiac arrest. Testing of blood samples drawn at the time of the arrest revealed hypokalemia and severe hyponatremia (<125 mmol/L). The patient died within a few days. From the autopsy, it was concluded that the patient had suffered severe brain edema due to hyponatremia.

The incident example describes a case in which laboratory values were not available to guide selection of IV fluids and the sodium–water imbalance was exacerbated by the care provider's lack of awareness of the potential for hyponatremia.

Main Theme: Incorrect Amount of IV Solution Infused

Analysis of the incidents involving infusion of an incorrect amount of IV solution revealed a number of contributing factors: lack of electrolyte monitoring and/or lack of response to monitoring results, knowledge deficit related to recognition of signs and symptoms of hyponatremia, inadequate monitoring of fluid intake and output, and knowledge deficit about management of hyponatremia. The following incident illustrates several of these contributing factors, including the need for vigilance even with IV solutions that are less likely to cause hyponatremia—like Ringers lactate (which is slightly hypotonic).

Incident example: A healthy older person underwent hip replacement surgery. The patient had hyponatremia (value unknown) on postoperative day 1 while receiving Ringer's lactate, so the rate of fluid administration was increased. The next morning (day 2), the sodium level remained low. The fluid was changed to sodium chloride 0.9% on the evening of day 2 after several litres of Ringers lactate was infused in the preceding 24 hours. By day 3, the sodium level had fallen even further. The patient became confused and experienced peripheral edema accompanied by difficulty breathing. The IV fluids were discontinued and with additional interventions, the patient recovered.

Discussion

The most devastating effect of a rapid decrease in serum sodium is brain swelling as water migrates into the brain cells, with potentially fatal results. In one study, nearly all neurological morbidity resulting from hospital-acquired hyponatremia was associated with administration of IV solutions known to predispose the patient to hyponatremia (see Table 1).⁶ Systematic monitoring of electrolytes and fluid status, recognition of signs and symptoms of hyponatremia (e.g., headache, irritability, confusion, restlessness, nausea, vomiting, weakness, a feeling of malaise, decreased level of consciousness), and appropriate follow-up interventions are critical to preventing serious harm.

The same precautions for prescribing medications should apply when prescribing IV fluids. Careful attention must be paid to the indication for use of IV fluids, and the rate and duration of administration must be based on appropriate monitoring of clinical and laboratory parameters, as well as consideration of other sources of fluid loss or gain. Acute hyponatremia may result when solutions are administered intravenously either for replacement of

fluids (i.e., hydration) or for maintenance of IV access (“to keep vein open” or TKVO), which makes it essential to select an IV solution with the appropriate constituents. Multiple studies have shown that using a sodium chloride 0.9% solution can reduce the likelihood of hyponatremia,⁶ and this approach could play an important part in reducing incidents of acute hospital-acquired hyponatremia.^{6,7}

Conclusion

This multi-incident analysis of hyponatremia incidents identified a number of vulnerabilities in clinical practice. Addressing knowledge deficits in both the recognition of the signs and symptoms of hyponatremia and fluid and electrolyte prescribing, as well as adopting systematic approaches to clinical and laboratory monitoring, are necessary to prevent hospital-acquired hyponatremia and to keep patients safe while they are receiving IV fluids.

Additional resources and information can be found at ISMP Canada’s Hospital-Acquired Hyponatremia Knowledge Exchange available at www.ismp-canada.org/hyponatremia/

Table 1. Examples of Fluids for Intravenous (IV) Administration

Fluid (Colloquial Names)	Sodium Content* (mmol/L)	Other Constituents	Notes
Sodium chloride 0.9% (normal saline, NS)	154	Water	Approximates the sodium content in blood serum. May cause hypernatremia.
Ringer’s lactate (lactated Ringer’s, LR, RL)	130	Water, potassium, calcium, chloride, lactate	May cause hyponatremia.
Sodium chloride 0.45% (1/2 normal saline)	77	Water	May cause hyponatremia.
Dextrose 5% in water (D5W)	0	Water, glucose	May cause hyponatremia.
Dextrose 5% and sodium chloride 0.45% (D5W 1/2 normal saline)	77	Water, glucose	Dextrose is metabolized in vivo and the solution becomes hypotonic after infusion.
Dextrose 3.3% and sodium chloride 0.3% (2/3 and 1/3)	51	Water, glucose	

*For reference, blood serum contains 135–145 mmol/L of sodium.⁷

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This segment of the bulletin describes a recent SafeMedicationUse.ca publication from ISMP Canada's Consumer Program.

November 2015 - Newsletter:

Combination Cold and Flu Products Cause Confusion

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Some nonprescription products contain more than one ingredient, and some products even contain more than one type of tablet within the same package. These combination products can be confusing for consumers, especially when they are not feeling well.

SafeMedicationUse.ca received a report from a consumer who purchased a cold and flu product that was sold as a combination package, with separate blister packs of medication intended for daytime and nighttime use. At bedtime, the consumer took what he thought was the nighttime tablet to help with sleep, but he had difficulty sleeping and experienced a loss in productivity the next day. The consumer later realized he had mistakenly taken the daytime tablet, because he had associated the tablet colours with the wrong times of day.

Tips for Practitioners:

- Remind consumers to **keep all medications in their original packaging.**
- When recommending or selling a combination product, **explain the use of each medication and when to take each one.**

Tips to Share with Consumers:

- **Always read the label of the original package carefully** before taking any medication. For medications in combination packages, make sure to match instructions of use with each medication in the package.
- **Store all medications in their original packaging**, so that dosing and safety information stays with the medications.
- **Do not rely on colour or appearance alone** to identify medications, their intended use, or the times when they must be taken.

For additional information on the use of combination products for consumers and practitioners, read the complete newsletter at: http://safemedicationuse.ca/newsletter/newsletter_ColdAndFlu.html



Consumers Can Help Prevent
Harmful Medication Incidents

SafeMedicationUse.ca

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The Canadian Medication Incident Reporting and Prevention System (CMIRPS) is a collaborative pan-Canadian program of Health Canada, the Canadian Institute for Health Information (CIHI), the Institute for Safe Medication Practices Canada (ISMP Canada) and the Canadian Patient Safety Institute (CPSI). The goal of CMIRPS is to reduce and prevent harmful medication incidents in Canada.



The Healthcare Insurance Reciprocal of Canada (HIROC) provides support for the bulletin and is a member owned expert provider of professional and general liability coverage and risk management support.



The Institute for Safe Medication Practices Canada (ISMP Canada) is an independent national not-for-profit organization committed to the advancement of medication safety in all healthcare settings. ISMP Canada's mandate includes analyzing medication incidents, making recommendations for the prevention of harmful medication incidents, and facilitating quality improvement initiatives.

Report Medication Incidents

(Including near misses)

Online: www.ismp-canada.org/err_index.htm

Phone: 1-866-544-7672

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