



Compliance with a Pediatric Clinical Practice Guideline for Intravenous Fluid and Electrolyte Administration

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Abstract

The occurrence of acute hyponatremia associated with cerebral edema in hospitalized children has been increasingly recognized, with over 50 cases of neurological morbidity and mortality reported in the past decade. This condition most commonly occurs in previously healthy children where maintenance intravenous (IV) fluids have been prescribed in the form of hypotonic saline (e.g., 0.2 or 0.3 NaCl). In response to similar problems at The Hospital for Sick Children (six identified through hospital morbidity and mortality reviews and safety reports prior to fall 2007), an interdisciplinary clinician group from our institution developed a clinical practice guideline (CPG) to guide fluid and electrolyte administration for pediatric patients. This article reviews the evaluation of one patient safety improvement to change the prescribing practice for IV fluids in an acute care pediatric hospital,

including the removal of the ability to prescribe hypotonic IV solutions with a sodium concentration of <75 mmol/L. The evaluation of key components of the CPG included measuring practice and process changes pre- and post-implementation. The evaluation showed that the use of restricted IV fluids was significantly reduced across the organization. Success factors of this safety initiative included the CPG development, forcing functions, reminders, team engagement and support from the hospital leadership. A key learning was that a project leader with considerable dedicated time is required during the implementation to develop change concepts, organize and liaise with stakeholders and measure changes in practice. This project highlights the importance of active implementation for policy and guideline documents.

The occurrence of acute hyponatremia in hospitalized children has been increasingly recognized, with over 50 cases of neurological morbidity and mortality reported internationally in the past decade (Moritz and Ayus 2003; National Patient Safety Agency 2007). Acute hyponatremia is defined as a fall in serum sodium to <130 mmol/L within 48 hours, and it can result in acute cerebral edema and brain stem herniation. Acute hyponatremia most commonly occurs

in previously healthy children where intravenous (IV) maintenance fluids have been prescribed in the form of hypotonic saline (Moritz and Ayus 2003), particularly in the perioperative period. In response to similar problems within this institution, an interdisciplinary clinician group from The Hospital for Sick Children (SickKids) developed a clinical practice guideline (CPG) to guide IV fluid and electrolyte administration in pediatric patients.

CPGs have many potential benefits, including an improvement in patient care and patient outcomes, support for the use of interventions that are of proven benefit and enhanced awareness of ineffective methods (Grimshaw and Russell 1993; Woolf et al. 1999). However, it is known that the publication and dissemination of CPGs alone do not generally result in the use of these guidelines in practice (Gross et al. 2001). To help clinicians make these changes, an implementation plan, ideally using a multi-strategic approach, is required (Grimshaw et al. 2004).

While many implementation studies have been conducted with physician groups, there is limited research to identify what strategies work best with nursing groups and interdisciplinary teams (Grimshaw et al. 2004; Thompson et al. 2007). Although healthcare professionals experience similar challenges when incorporating CPGs into practice, there are differences that likely influence some daily practices, such as the decision-making processes within the different clinical groups (Registered Nurses' Association of Ontario 2002; Thompson et al. 2007). The lack of evidence to support or refute the effectiveness of specific interventions with nursing and interdisciplinary teams made it difficult to provide our team with the “magic bullets” for implementation. However, we used the information regarding implementation strategies from published research and combined this with the practical experiences with our interdisciplinary teams to create an implementation plan.

This article reviews the evaluation of one patient safety improvement of the CPG involving change: the prescribing practice for IV fluids in an acute care pediatric setting, including the restriction of the ability to prescribe hypotonic IV solutions with a sodium concentration of <75 mmol/L. The purpose of

this paper is to describe the implementation process used and to share the success factors and challenges that were encountered when systemically implementing a CPG and changing practice in a tertiary care pediatric hospital.

Change Management Process

Hyponatremia due to inappropriate IV fluid prescription was identified as a key patient safety issue following a hospital morbidity and mortality review in 2005. This resulted in recommendations for change being distributed by memo to senior medical staff, with minimal influence on practice. In 2007, a CPG titled Fluid and Electrolyte Administration in Children was developed and approved by a committee consisting of physicians, a clinical director, a nurse educator and the director of pharmacy. The guideline has recommendations that include patient assessment, the prescription of IV fluids based on serum electrolytes or patient diagnosis, the monitoring of serum electrolytes and the treatment of hyponatremia.

The lead for the implementation of the CPG was the quality analyst who co-developed the CPG implementation plan, with assistance from the associate risk manager. Implementation took place over a three-month period in 2007.

This paper focuses on one key patient safety issue – the reduction of the number of hypotonic solutions prescribed.

Implementation Planning

An initial step in the planning process for implementation was developing a project plan that included implementation goals, the identification of key stakeholders, anticipated facilitators and challenges, communication and education strategies

Table 1. Categorization of intravenous solutions for use with pediatric patients

Category	Action	Solution Type	Mean Bags/Unit (range)		Significance
			Pre-implementation	Post-implementation	
A	To be removed from the hospital	A.1 0.3 NaCl with 3.3% dextrose	30.0 (0–126)	0	<i>p</i> < .007
B	To be restricted to administration of drugs, emergency use or use with a consult from the nephrology service	B.1 0.2 NaCl with dextrose	17.8 (0–96.3)	6.1 (0–39.5)	<i>p</i> = .08; not significant
		B.2 Dextrose solutions (D5W, D10W)	1.7 (0–9.1)	0.6 (0–2.3)	Not significant
C	Approved solutions for general use	Ringer's lactate 0.45% NaCl ± dextrose, 0.9 NaCl ± dextrose	Not applicable – concerned with changes in volumes of solutions A and B only		

and timelines. It was important to identify and categorize the IV solutions that were currently available for use within the hospital. An inventory of all IV solutions and volumes used by each clinical area was provided by the purchasing department. The inventory was reviewed by the chief of the critical care unit, the director of pharmacy and a nurse risk manager. The IV solutions were divided into three categories (Table 1): “A” solution (0.3 NaCl with 3.3% dextrose), which was to be removed entirely from use; “B” solutions, which were to be restricted for use; and “C” solutions, which were approved for general use.

The second step in the planning process was to identify anticipated facilitators and challenges to making these changes hospital-wide. The organizational setting may be the most influential factor that impacts the implementation of new knowledge and processes. Acquiring a good understanding of the setting and the obstacles to change in the hospital were essential to developing an effective strategy for change (Grol and Wensing 2004). To accomplish this, an environmental readiness assessment (Registered Nurses’ Association of Ontario 2002) was completed to identify organizational factors such as the “climate for change,” available resources (i.e., training and leadership) and staff attributes (i.e., adaptability, attitudes and interdisciplinary relationships). In addition, a gap analysis was conducted to determine the discrepancies between the new clinical recommendations and current practice (Figure 1). These exercises,

in addition to concepts from the literature (Grimshaw et al. 2004) and known change management concepts (Institute for Healthcare Improvement n.d.), were key in developing a multi-faceted approach to hospital-wide implementation of the guideline.

Implementation

A rollout schedule was agreed upon between the implementation team, central stores department and clinical area managers. Slight modifications to the order and dates of the original schedule were made to align with other initiatives that were also being implemented. The changes were piloted on two nursing units during the first two weeks to identify any major problems that might occur before the implementation was spread to the remainder of the hospital. The staged rollout was scheduled over a six-week period so that the team could adjust for unexpected issues or concerns that arose along the way.

The implementation team recognized the importance of obtaining buy-in from the front-line staff *prior* to the rollout. The project lead contacted each clinical area manager to discuss the timing of the changes (described above), what IV fluids and volumes they would stock in the future, how these changes might impact patient care in their area and how they could work together and to identify what additional support each clinical area might require to make these changes. Support for the transition included the following:

Figure 1. Sample gap analysis for one recommendation

Recommendation	Current Practice	Ideal Practice	Methods to Close Gap	Facilitators/Challenges to Closing Gap
1. 0.3 NaCl with 3.3% dextrose is no longer available in the hospital. 0.2% NaCl with dextrose and 5 or 10% dextrose in water all contain substantial amounts of electrolyte free water and <i>must not be used as maintenance IV fluids</i> . ¹⁻³ Patients with a demonstrable free water deficit may require the administration of these types of hypotonic solutions. The use of these fluids is <i>restricted to the CCU, NICU and nephrology services</i> . Consultation should be obtained from nephrology if these solutions are being considered. (Evidence Grade B)	1.1 All solutions are available on unit for MD to prescribe	1.1.a Eliminate ability to prescribe 0.3 NaCl with 3.3% dextrose (solution A)	1.1.a.i Liaise with pharmacy and stores to remove solution from hospital (Solutions B)	1.1.a.i Minor: time – needs expedited approval
		1.1.b Restrict use of dextrose 5% and 10%, 0.2% NaCl with dextrose (solutions B)	1.1.b.i Program forcing function within ordering system that requires nephrology consult before order is completed	1.1.b.i Intermediate: conflict with IT department commitments to new ordering system; can be done but not until 2010
			1.1.b.ii Stores to restrict the amount of solutions stocked within each unit	1.1.b.ii None; change implemented successfully
			1.1.b.iii Education and reminders	1.1.b.iii None, but known to have limited impact

CCU = critical care unit; IV= intravenous; IT = information technology; MD = physician; NICU = neonatal intensive care unit.

- Standardized educational slides for the weekly team meetings
- Reminders in the form of wall posters and on computer terminals used for computer physician order entry (CPOE)
- Coloured place cards on the bins on the stores carts that stored the restricted solutions, reminding nursing staff that a consult was required to use these solutions
- Reorganization of the IV solutions on the central stores carts (i.e., restricted solutions were put in a new location on the cart)
- Changes in the quotas of the IV solutions to anticipate the gap from the solutions that were removed or restricted
- Search and removal of all A and B solutions from the clinical areas and crash-and-code carts (these solutions were not always kept on the central stores carts)

A communications strategy was developed to announce the changes in availability of the IV solutions. The following key components for communication were included:

- Education slides and posters for clinical area educators
- Standardized e-mail messages to be disseminated by the chiefs of nursing and critical care medicine and the vice-president of medical and academic affairs to predetermined groups
- Standardized memos to appear on the hospital intranet home page, e-mail welcome page and hospital newsletter
- Individual e-mail and telephone contacts from the implementation lead to each clinical area manager
- Individual contact from the lead physician to the chief physician for an area to discuss changes upon request
- Attendance at clinical area team meetings on request
- Presentations of the practice changes by medical staff to the Medical Advisory Committee and to divisional meetings

The changes of the IV solutions stocked in the patient areas were made by a representative from stores department, which is the primary supplier of IV solutions to all in-patient and ambulatory patient areas within the hospital, with the exception of some premixed solutions from pharmacy. This representative was responsible for searching and removing all A and B solutions from the storage areas and placing coloured place cards on the bins highlighting the changes and directing people to the CPG for more information. There was ongoing communication between the stores representative and the project lead to track when the inventory in each nursing unit had been reviewed and revised.

Evaluation

The IV fluid inventory was used to measure the overall use of each solution category and type of solution. Data from six months pre-implementation and six months post-implemen-

tion were compared using Student's *t*-test. Changes in the mean number of bags per unit for each of the A and B solutions are presented in Table 1. There was a significant drop (30 bags/unit to 0 bags/unit) in the use of the A solution. Type B.1 solutions decreased from an average of 17.8 bags/unit to 6.1 bags/unit bags per month (not significant, $p < .08$), and type B.2 decreased from 1.7 bags/unit to 0.6 bags/unit (not significant). Prior to the implementation, there were six incidents of hyponatremia identified through morbidity and mortality reviews and safety reports. Since this CPG was implemented, there have been no reported events of hyponatremia related to IV fluids.

Discussion

Implementing change on the front lines is challenging since an increased demand in healthcare for better accountability, patient safety and the use of evidence-based medicine all contribute to a culture where there are frequent improvement initiatives and practice changes. Front-line staff have multiple responsibilities in their day-to-day practice, most importantly immediate patient care, and often struggle to find dedicated time for initiatives. Likely the most important element to the success of this initiative was having a dedicated project lead with protected time to coordinate the development and implementation of the CPG, an element supported by senior leadership.

The project lead maintained the initiative's momentum by managing the administrative aspects of the project, such as developing an implementation plan and timeline, developing tools and materials to support the change, coordinating team roles and responsibilities and facilitating communication among the implementation team, the front-line workers and senior leadership. The project lead provided tools and materials to make the changes straightforward for the front-line teams, as well as education on the CPG and changes that would affect patient care. She was identified and available to act as a resource for any of the stakeholders or clinical areas. She was the liaison between the clinical staff, information services, stores and pharmacy. Her duties included developing and providing copies of posters directly to the clinical managers and the electronic PowerPoint slides for education and standardized memos for circulation. Addressing minor details such as the lamination of posters for the operating rooms or providing a requested number of copies of the posters helped to minimize problems during the rollout in each area.

The second element that facilitated this initiative was the open communication and flexibility of the implementation team with the front-line staff and administrative services. The changes in availability of solutions were presented early in the implementation process to the managers and physicians. Feedback from the clinical team was sought about potential issues, and support was provided to help them facilitate the changes. Many areas required consultation with the physician

leads to determine which IV solutions would best replace the removed and restricted solutions for their patient populations.

Flexibility was important when scheduling timelines for the implementation. While maintaining a schedule and plan was vital to the integrity of the initiative, the implementation team also recognized the need for flexibility to work with other initiatives within the hospital and to take into account patient-population needs that are unique to certain units. For example, a minor adjustment was the two-week delay of the rollout for one unit due to a conflict with a local initiative that was being implemented during that time. Another unit needed to maintain a larger quantity of stock of one of the restricted solutions due to the special needs of its patient population. The physician leads worked with this front-line team to gain a consensus on a safe amount of this solution to maintain in stock within this area.

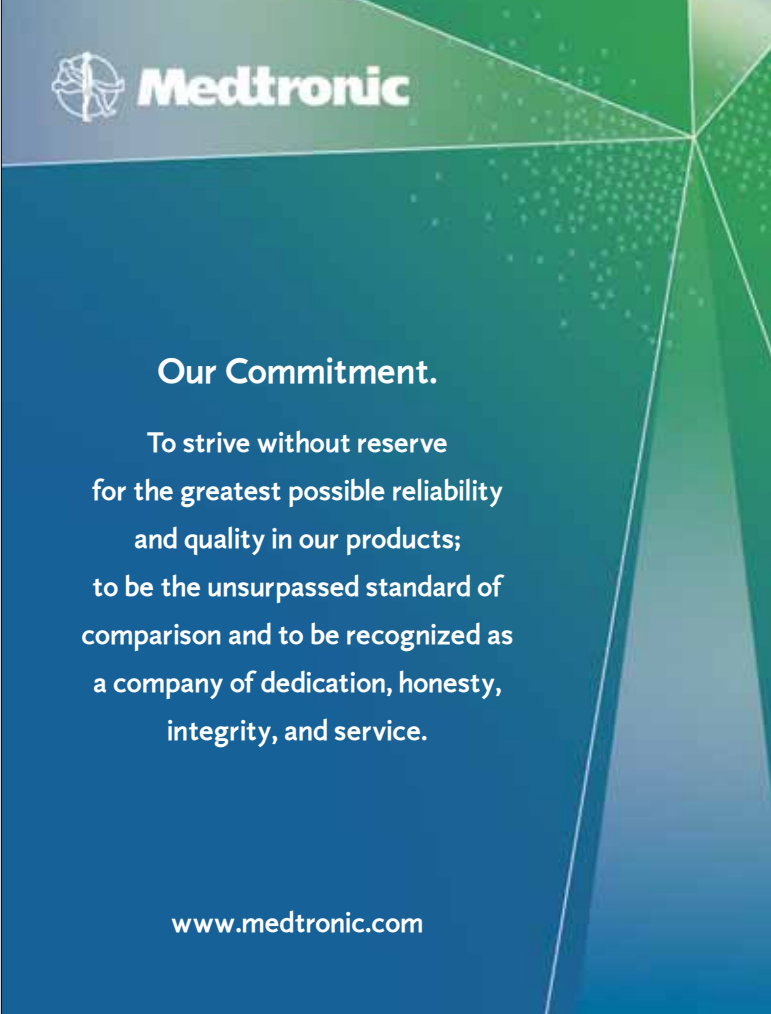
Education was used to communicate the changes to the front-line staff. A nursing educator was consulted for the development of tools such as posters, presentation slides and standardized concise messages. These standardized tools were provided to the managers and educators. Staff were directed to the CPG if more information or an explanation was required. An emphasis was placed not only on what the changes entailed but also on the reasoning for making these changes.

Front-line managers and educators were provided with whatever support they felt was important to achieve the changes required in their area. Since the physician leads had been providing ad hoc education throughout the hospital over the previous few years, some units required little education and were able to make these changes with relative ease. Indeed, a few units had already begun to make some of these changes. Other units required more support to acquire buy-in from the front-line staff and requested the attendance of the project or physician lead at a team meeting for a discussion. Completing the environmental readiness assessment helped the implementation team to identify the areas likely to require more support and to anticipate methods to obtain better buy-in. Overall, the most successful method for buy-in was to listen to the staff concerns and work with the team to agree upon a mutually acceptable resolution. Simply mandating these changes would not have led to a successful practice change.

Solution A was identified as not safe for use with pediatric patients. Since SickKids is a pediatric hospital, removing solution A completely from the hospital was a fail-safe way

to ensure no child would receive it. This step was approved in consultation with key stakeholders from nursing, medicine and pharmacy. Staff in purchasing and stores were engaged to ensure this solution would not be brought into the hospital. Forcing functions, such as this, are not always feasible; but, where possible, they are powerful strategies to prevent errors.

This initiative was certainly not without its challenges. It was not possible to make changes to a new CPOE system prior to implementing the CPG. Therefore, it was necessary to put extra effort into restricting the solutions available for use by education and reminders until the force functions could be programmed into the new CPOE. An example of a forcing function to be supported by the CPOE is that a provider has to order a nephrology consult before ordering any of the B Solutions. SickKids is a teaching institution with numerous medical residents and fellows participating in training rotations. Many of these educational placements are short term, resulting in new medical trainees continually circulating throughout the



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hospital. The educational challenges associated with this were twofold. First, this change in IV solution prescription practice is a relatively new concept within pediatrics, and these changes do not apply to adult patient populations. Therefore, trainees who had been participating in non-pediatric rotations were accustomed to prescribing A and B solutions for their patients. Secondly, other forms of medical education, such as textbooks (Bianchetti and Bettinella 2008), have just recently included this practice as it has only been discussed in the academic literature in the past decade. Since including changes within the CPOE was not feasible at the time of implementation, a mechanism to constantly educate and monitor the prescription practices of the trainees was required until the CPOE system was programmed.

Multiple strategies were employed to help bridge this gap. The CPG is included in the medical resident handbook that is distributed to medical trainees when they start at SickKids. Nursing helped to support the implementation by guiding new trainees in writing their orders for IV solutions. Limiting the volumes of the restricted solutions as well as using reminder cards on the storage carts also serve as prompts to nurses to have physicians order the safe solutions. Although passive dissemination of educational materials and reminders is known to have minimal impact behaviours, combining these multiple strategies likely provided a stronger chance of preventing an error.

Conclusion

Practice change can be a slow process. This project demonstrates the benefit of an active implementation strategy to shorten the time required to implement a CPG. Using a multi-faceted approach was key to successful implementation, particularly in reducing the number of hypotonic solutions prescribed. Lessons learned from this initiative include the importance of dedicated time for a project lead; an implementation plan; support from the executive sponsors and physician leads; open communication; and flexibility and promptness in addressing stakeholder issues and concerns. **HQ**

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