ISMP Canada

Enhancing safety with potassium phosphates injection

By Patti Cornish, RPh, BScPhm, Sylvia Hyland, BScPhm, MHSc (Bioethics), and Christine Koczmara, RN, BSc

Abstract

The inadvertent administration of concentrated potassium chloride resulting in patient death is well-documented in Canada and other countries. Vials of potassium phosphates contain more than twice the concentration of potassium compared to vials of potassium chloride concentrate. If inadequately diluted or administered too rapidly, intravenous potassium phosphate can also lead to serious patient harm. This article contains information reprinted with permission from an ***ISMP Canada Safety Bulletin*** *(ISMP Canada, 2006, April 25) for the purpose of enhancing safety with potassium phosphates injection.*

Background

The dangers associated with inadvertent administration of concentrated **potassium** solutions are well-known. Adverse events resulting in death from the inadvertent injection of concentrated potassium chloride have been well-publicized (ISMP, 1996; ISMP Canada, 2003; The Joint Commission, 1998; NPSA, 2002; Reeve & Allinson, 2005). ISMP Canada and the Canadian Council on Health Services Accreditation (CCHSA) recommend that concentrated electrolytes be removed from patient care areas. Many Canadian hospitals have succeeded in removing concentrated potassium chloride products from patient care areas (Eli Lilly, 2006; ISMP Canada, 2003). The approach to removal of concentrated potassium phosphates solutions, however, is not as straightforward, largely due to the lack of availability of commercially prepared premixed infusion solutions.

Safety issues with potassium phosphates injection

Potassium phosphates injection is designated as a "high-alert" medication for the following reasons:

- Vials of potassium phosphates contain more than twice the concentration of potassium (4.4 mmol/mL) compared to potassium chloride concentrate (2 mmol/mL). If inadequately diluted or administered too rapidly, intravenous potassium phosphate can cause serious adverse consequences.

Other safety issues include:

- Product labels for commercially available potassium phosphates injection can be confusing because of the nature of the product (see Figure One). A variety of measurement units (mg, mEq, mmol, mOsm, mL) are used on the labels. The variety of information may cause confusion and may lead to calculation errors during preparation of doses for intravenous infusion.
- Variations in the way prescribers express doses of potassium phosphate may lead to error-prone conversions between milligrams (mg), milliequivalents (mEq), and millimoles (mmol) for the phosphorus component, as well as inattention to the amount of potassium delivered with each dose.

Note: The terms phosphate and phosphorus are often used interchangeably and this is acceptable for the purposes of prescribing. Although phosphorus is the elemental form and phosphate exists in various ionic forms, the millimolar content of phosphorous can be considered virtually identical to that of phosphate. Therefore, when prescribing a phosphate product, the recommendation (see below) is to specify the dose in millimoles (mmol).

Background information on the treatment of hypophosphatemia

Hypophosphatemia is a frequently encountered metabolic complication in critically ill hospital inpatients. Moderate hypophosphatemia is usually defined as serum phosphate in the range of 0.4-0.8 mmol/L and severe hypophosphatemia as a level below 0.4 mmol/L (Bugg & Jones, 1998; Dickerson, 2001). Oral phosphate supplementation is preferred for asymptomatic patients with mild to moderate hypophosphatemia when the enteral route is feasible. Intravenous phosphate supplementation is necessary for patients with severe hypophosphatemia, for symptomatic patients with moderate hypophosphatemia, or for patients in whom the enteral route is not feasible. Either *potassium* phosphates or *sodium* phosphates may be used for parenteral phosphate replacement. The electrolyte content of each of these products is noted in Figure Two.

Recommendations for preventing adverse events

1. Develop standard protocols for intravenous phosphate supplementation

As an essential first step to improving safety, it is recommended that institutions develop standardized dosing and monitoring protocols for intravenous phosphate replacement therapy. The development of such protocols will encourage the use of standardized doses and solutions. There is confusion about appropriate dosing and administration of phosphate infusions, regardless of whether potassium phosphate or sodium phosphate is used. This confusion may arise because the product monograph lacks clear dosing recommendations, because the labelling on the vials is confusing, and because clinical studies have used a variety of dosing regimens.

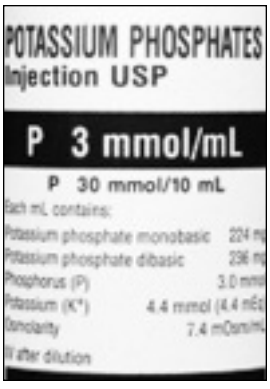

Figure One: Photograph of a commercially available potassium phosphates injection label illustrating the potential for confusion because of the nature of the product.

2. Develop "order sets" (pre-printed or electronic) for phosphate infusions

To ensure compliance with standard protocols, the development of order sets (pre-printed or electronic) for phosphate infusions should be considered. These orders should clearly specify the **dose in mmol of phosphate,** the type and volume of infusion solution, and the recommended rate of administration. As well, the mmol of potassium or sodium provided per dose should be stated on the pre-printed orders. In addition, for potassium phosphate infusions, it may be helpful to include a prompt to ensure that the patient's serum potassium results are checked to ensure they are below a predetermined level. The text for labels for infusion bags and entries for computer-generated medication administration records (MARs) should also follow a standard format.

Potassium Phosphates Injection	**Sodium Phosphates Injection**
10 mL vial	10 mL vial
Each millilitre supplies:	**Each millilitre supplies:**
4.4 mmol of potassium	4 mmol of sodium
3 mmol of phosphorus	3 mmol of phosphorus

Figure Two: Electrolyte content for potassium phosphates and sodium phosphates injections. Either product may be used for parenteral phosphate replacement.

3. Remove potassium phosphates injection from patient care areas

The removal of concentrated potassium phosphates injection from patient care areas is an important patient safety initiative. How this is realized will depend on the decisions that are made during the development of standard protocols for phosphate infusion.

- Preferential use of sodium phosphate infusions for parenteral phosphate replacement may be an option for minimizing risk, especially when infusion bags cannot be prepared in the pharmacy. Sodium phosphates injection provides the same phosphate content as potassium phosphates injection, and presents less risk to patients if improperly diluted or rapidly infused. In a publication by Esmail et al. (2005) recommendations include the substitution of sodium phosphate for potassium phosphate for certain patients to facilitate removal of concentrated potassium phosphates from patient care areas. Since the product labels for sodium phosphates injection may be as confusing as those for potassium phosphates injection, it is crucial to establish standard dosing protocols and guidelines for the preparation, labelling and administration of infusion bags.
- If it is decided that potassium phosphate infusion is desirable for some or all patients with hypophosphatemia, the removal of the concentrated product from patient care areas will require a system that includes pharmacy-based preparation of standard infusion bags of potassium phosphate.

Collaboration among prescribers, nurses, and pharmacy personnel will be key to the success in implementing safety strategies for the removal of potassium phosphates injection from critical care and all other patient care areas within your organization. As with the removal of concentrated potassium chloride, sharing your learning related to the implementation of safety strategies beyond your organization is also an integral component towards advancing medication safety nationally with potassium phosphates injection.

ISMP Canada gratefully acknowledges the valuable lessons learned and information reported by professionals in the Canadian health care community that can then be shared to enhance medication system safety. All ISMP Canada Safety Bulletins are available from **http://www.ism--canada.org/ISMPCSafetyBulletins.htm**

ISMP Canada is a national voluntary medication incident and 'near miss' reporting program founded for the purpose of sharing the learning experiences from medication errors. Implementation of preventative strategies and system safeguards to decrease the risk for error-induced injury and thereby promote medication safety in healthcare is our collaborative goal.

Medication Incidents (including near misses) can be reported to ISMP Canada:
(i) through the website
http://www.ismp-canada.org/err_report.htm or
(ii) by phone: 416-733-3131 or toll free: 1-866-544-7672.

ISMP Canada guarantees confidentiality and security of information received, and respects the wishes of the reporter as to the level of detail to be included in publications.

About the authors

Patti Cornish, RPh, BScPhm, is the Pharmacist with the Patient Safety Service at Sunnybrook Health Sciences Centre. She is involved with various activities aimed at improving medication systems to optimize patient safety.

Sylvia Hyland, BScPhm, MHSc (Bioethics), is Vice-President of the Institute for Safe Medication Practices Canada (ISMP Canada), Toronto, Ontario.

Christine Koczmara, RN, BSc, is a senior medication safety analyst with the Institute for Safe Medication Practices Canada (ISMP Canada). She also holds a casual position as a bedside nurse in an Intensive Care Unit (ICU).

References

Bugg, N.C., & Jones, J.A. (1998). Hypophosphatemia: Pathophysiology, effects and management on the intensive care unit. **Anaesthesia, 53,** 895-902.

Dickerson, R.N. (2001). Guidelines for the intravenous management of hypophosphatemia, hypomagnesemia, hypokalemia, and hypocalcemia. **Hospital Pharmacy, 36,** 1201-1208.

Eli Lilly Canada. (2006). Ethics in hospital pharmacy. **Hospital pharmacy in Canada.** Retrieved October 4, 2007, from www.lillyhospitalsurvey.ca/HPC2/content/rep_2006_toc.asp

Esmail, R., Cummings, C., Dersch, D., Duchsherer, G., Gilowa, J., Liggett, G., et al. (2005). Using healthcare failure mode and effects analysis tool to review the process of ordering and administering potassium chloride and potassium phosphate. **Healthcare Quarterly, 8**(Spec No.), 73-80.

Institute for Safe Medication Practices. (1996, November 20). KCl deaths: Art imitates life. **ISMP Medication Safety Alert, 1**(23), 1-2.

Institute for Safe Medication Practices Canada. (2003, November). More on potassium chloride. **ISMP Canada Safety Bulletin, 3**(11), 1-2. Retrieved October 3, 2007, from www.ismp-canada.org/download/ISMPCSB2003-11KCl.pdf

Institute for Safe Medication Practices Canada. (2006, April). Safety strategies for potassium phosphates injection. **ISMP Canada Safety Bulletin, 6**(12), 1-2. Retrieved October 1, 2007, from www.ismp-canada.org/download/ISMPCSB2006-02PotassiumPhosphates.pdf.

National Patient Safety Agency. (2002, July 23). **Patient safety alert.** Retrieved October 3, 2007, from www.npsa.nhs.uk/site/media/documents/486_riskalertpsa01.pdf

Reeve, J.F., & Allinson, Y.M. (2005, February). High-risk medication alert: Intravenous potassium chloride. **Australian Prescriber, 28**(1), 14-16. Retrieved October 3, 2007, from www.australianprescriber.com/magazine/28/1/14/6/

The Joint Commission (JCAHO). (1998, February 28). Medication error prevention: Potassium chloride. **Sentinel Event Alert, 1.** Retrieved October 3, 2007, from www.jointcommission.org/SentinelEvents/SentinelEventAlert/sea_1.htm

Call for task force members – Dynamics 2009

Dynamics 2009 will be held in Fredericton, New Brunswick, and will be chaired by Cecilia St. George-Hyslop. Any CACCN member interested in working on this committee should submit a resume and summary of conference planning experience to the CACCN national office by March 1, 2008. Selection of the task force members will take place in March 2008. For further information on this exciting opportunity, please contact the CACCN national office, P.O. Box 25322, London, Ontario N6C 6B1, **www.caccn.ca**, e-mail: **caccn@caccn.ca**, phone: (519) 649-5284, fax: (519) 649-1458.

Dynamics: The Official Journal of the Canadian Association of Critical Care Nurses is looking for members to join the Editorial Review Board

Requirements include:
- Current CACCN member
- Demonstrated ability to write and publish professionally
- Graduate degree preferred
- Able to perform a blind review process within three weeks

If you are interested, please forward a letter of intent and a copy of your CV to the Clinical Editor at the address on page 3.

Appointments are made by the board of directors for a term of two years.