ISMP Canada

Preventing substitution errors involving high-concentration heparin products

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Abstract

Critical care practitioners routinely administer heparin for various indications (e.g., treatment of acute coronary syndrome, venous thromboembolism prophylaxis, line maintenance) and by various routes (e.g., intravenously, subcutaneously). Knowledge of reported incidents involving high-concentration heparin products can increase practitioner awareness of risks for error-induced injury associated with storage and administration of anticoagulants, such as heparin. Substitution errors leading to administration of an incorrect dose of unfractionated heparin are highlighted and suggestions for system-based error prevention strategies are provided.

"As part of a collaborative initiative to understand the patient safety issues related to the use of anticoagulants, ISMP Canada conducted an Anticoagulant Safety Survey of Canadian hospitals in spring 2006. The goal of the survey, the first pan-Canadian survey of its kind, was to gain information on the storage and use of heparin products, the use of venous thromboembolism (VTE) prophylaxis in hospital patients, and the management of patients receiving anticoagulants" (ISMP Canada, 2006, p.1). This article highlights the preliminary findings from the anticoagulant survey regarding storage of unfractionated heparin, information from error reporting programs and shares learning from medication incident reports involving the inadvertent administration of high-concentration heparin (excluding infusion pump programming errors).

Preliminary survey results: Storage of heparin

The preliminary survey results indicate that 90% of respondents (n= 195) maintain heparin as stock in patient care areas and 55% of these have no safeguards in place to avoid mix-ups between heparin products of different concentrations (ISMP Canada, 2007 December). Storage of high-concentration heparin products (i.e., 10,000 units/mL) in patient care areas is of particular concern since it presents a high risk of harm if inadvertently selected for administration.

Error reporting program information

In the MedMarx Data Report, heparin was the third most commonly reported drug involved in medication incidents causing harm in the United States (Hicks, Becker, & Cousins, 2006). Furthermore, a review by the Pennsylvania Patient Safety Authority of all medication-related incidents that occurred from June 2004 to December 2006 reported that 7.4% involved anticoagulants, such as heparin and warfarin (Patient Safety Authority, 2007). A recent report released by U.S. Pharmacopeia indicates that the "percentage of harm [from errors involving anticoagulants] is approximately two times higher than the percentage of harm seen for all errors reported to MedMarx for the corresponding reporting period [January 1, 2001 to December 31, 2006 inclusive]" (USP, 2008).

ISMP Canada's database of medication incident reports identified anticoagulants among the top 10 drugs reported as causing harm through medication error. As of December 2007, the database contained 789 reports involving unfractionated heparin, 60 of them resulting in patient harm or death. Of these 60 incidents:

- 38 (63%) involved the administration stage of the medication use system,
- 12 (20%) involved the monitoring stage, and
- 9 (15%) involved the order entry or transcription stage. (ISMP Canada, 2007 December 11).

Among these incidents, the most common type of error was incorrect dose (18/60 incidents or 30%), followed by incorrect drug (15/60 incidents or 25%) (ISMP Canada, 2007 December 11).

Incident reports described

The following are incident reports from ISMP Canada and ISMP (U.S.), which involved substitution errors leading to administration of incorrect heparin doses.

"A physician asked for heparin 2,000 units during a procedure. The nurse retrieved two vials of heparin from an automated dispensing cabinet that was supposed to be stocked with 1,000 units/1 mL vials. But a pharmacy technician had accidentally stocked the cabinet with look-alike vials of 10,000 units/1 mL heparin vials. Both concentrations... are in the same size vials with similar orange-brown labels and vial caps... causing the nurse to overlook the stocking error. The patient received heparin 20,000 units, but the nurse quickly noticed the mistake and the patient received protamine with no resultant harm. In the pharmacy, the 10,000 units/mL concentration was stored right next to the 1,000 units/mL concentration, making it easy to grab the wrong vial" (ISMP, 2003, p. 1).

"News media from around the country have recently published stories about the tragic deaths of three infants…who received overdoses of heparin. Apparently, a pharmacy technician accidentally placed 1 mL vials of heparin containing 10,000 units/mL into a unit-based automated dispensing cabinet (ADC) in the drawer where 1 mL vials of heparin 10 units/mL were normally kept. The vials were the same size, and they looked similar, although their caps and labels were a different shade of basically the same color… Several nurses had requested heparin 10 units/mL vials from the ADC and were

directed to that drawer, but the nurses did not notice that the vials contained the wrong concentration. Three other infants also received a heparin flush using the wrong concentration, but the adverse effects of the drug did not result in death" (ISMP, 2006, p. 1).

"Three infants …received 1,000 times more heparin than intended when vials containing 10,000 units/mL instead of 10 units/mL were used in error to flush the infants' vascular access lines… intense media attention given to these errors is related to the fact that two of the infants are the newborn twins of celebrities… Fortunately, according to news reports, none of the affected infants suffered lasting adverse effects from the error… Recently, [the manufacturer] revised the packaging and labelling on its 1,000 units/mL, 5,000 units/mL, and 10,000 units/mL heparin vials" (ISMP, 2007, p. 1).

"An adult patient was admitted to hospital for surgery. A triple-lumen central venous access device (CVAD, also known as a central venous line) was inserted pre-operatively. Post-operatively, each of the three ports of the CVAD was intermittently flushed three times a day with heparin flush solution. No other anticoagulant was prescribed. On post-operative day five, the patient experienced a bleed and a hypotensive episode. Blood work revealed a significantly elevated activated partial thromboplastin time (aPTT) at >180 seconds and an elevated international normalized ratio (INR). Computed tomography (CT) of the head the following day revealed intracerebral hemorrhage. Although vitamin K, plasma, and protamine were given, the patient died within the next 24 hours. The hospital completed a detailed investigation in follow-up. While no specific event was determined to have directly contributed to the patient's death, a review of the circumstances of the case suggested the possible administration of a higher dose of heparin than was intended. The storage of high-concentration heparin vials close to low-concentration heparin flush products on the nursing unit was identified as a risk for error" (ISMP Canada, 2006, p. 1).

"A triple-lumen catheter was inserted into a patient requiring central venous access (also known as a central venous line [CVL] or central venous access device [CVAD]). After insertion, 1 mL of heparin 10,000 units/mL (instead of the intended 1,000 units/mL) was diluted with 9 mL normal saline and administered into each of the three lumens (total of 30,000 units of heparin). The next day, a nurse found the central line catheter had been accidentally pulled out. Since central venous access was still required, it was decided to reinsert another CVL. Again, three 1 mL vials of concentrated heparin (10,000 units/mL) were used (each diluted with 9 mL normal saline). However, the total dose of heparin administered after the second CVL insertion is unknown. The following day, there was a decrease in the patient's blood pressure and severe bruising at the insertion site. The patient was found to have an elevated aPTT and INR, and a substantial decrease in hemoglobin. Treatment included administration of intravenous fluids, plasma volume expander Pentaspan®, fresh frozen plasma, packed red blood cells, and platelets. The patient was transferred to the intensive care unit, but later developed septicemia from an infected hematoma and died of complications a few weeks later…" (ISMP Canada, 2004, p. 1).

Multiple issues often underlie the inadvertent administration of high-concentration heparin. Examples of contributing factors to such incidents include:

- "The storage of high-concentration heparin vials close to low-concentration heparin flush products" (ISMP Canada, 2006, p. 1).
- "Often, more concentrations than necessary are present in both the pharmacy and patient care area stock." (ISMP, 2003, p. 1).
- Confirmation bias that can cause a health care professional to read a label or select a drug product and "see" what they expect to see, rather than what is actually selected (ISMP, 2006; ISMP, 2007).
- "Incomplete communication between physicians and nurses at the time of gathering drugs and supplies for CVL insertion and during procedure" (ISMP Canada, 2004, p. 1).

In addition, confusion can arise from the various types of CVADs. Depending on the CVAD, some protocols may combine flushing and locking with a low-concentration heparin product in one step. Others require locking the CVAD with higher-dose heparin in a volume that is equivalent to the lumen and then require the practitioner to withdraw the heparin (to prevent systemic administration) prior to flushing with normal saline (ISMP Canada, 2004).

Recommendations

"Patient injury as a result of a substitution error can occur in any hospital where vials of concentrated heparin, such as 10,000 units/mL, are available in patient care areas." (ISMP Canada, 2004, p. 1). Incidents can also occur when high-concentration heparin is not separated from other heparin products, such as flush solutions, on nursing units as well as in the pharmacy (ISMP, 2006). Recommendations include:

- Use unit dose heparin formats whenever possible.
- "Use heparin 5,000 units single-dose ampoules or pre-filled syringes for subcutaneous administration whenever possible.
- Use marketed, premixed, dilute solutions of heparin for intravenous indications" (ISMP Canada, 2006, p. 1).
- "Higher-concentration heparin products such as the 25,000 units/mL in 2 mL vials should not be available in patient care area medication stock." (ISMP Canada, 2006, p. 1).
- Routinely assess for the look-alike potential of medications. Ideally, this should be assessed during formulary evaluation of products and before purchasing decisions are made. "Reduce look-alike potential of products by purchasing different strengths from different manufacturers" (ISMP, 2006, p. 2).
- Standardize the concentrations used in an effort to limit the number of heparin products needed in patient care area stock (ISMP Canada, 2006).

- Regularly assess the need to retain various heparin products in patient care area stock. Products (concentrations and formats) infrequently used should be removed and supplied on an "as needed" basis by pharmacy (ISMP, 2007).
- Critically review existing protocols for the use and care of CVADs (ISMP Canada, 2006, p. 2).
- "Provide readily accessible protocols that outline procedures for flushing and locking of the various CVADs. Some hospitals have developed summary charts of protocols as a reference for use at the point of care" (ISMP Canada, 2004, p. 2).
- Require an independent double check of products added to automated dispensing cabinets (ISMP, 2006).
- Work towards the implementation of barcode technology (ISMP, 2006).
- "Educate practitioners about the association between unexpected clinical symptoms and medication incidents. Investigation of unexpected elevation of aPTT or INR, or of unexpected bleeding, should consider the possibility of medication error" (ISMP Canada, 2006, p. 2).
- "Develop guidelines for reversal of excessive anticoagulation" (ISMP Canada, 2006, p. 2).

Conclusion

According to the recent U.S. Pharmocopeia report, "the administration of anticoagulant medications represents the most problematic phase and one with the greatest opportunity for focused improvement strategies" (USP, 2008, p. 3). Critical care practitioners routinely administer heparin for a variety of indications and by various routes. Knowledge of published reports can provide the opportunity for practitioners to learn from organizations that have experienced heparin-related incidents. Multiple strategies are required to reduce the possibility of inadvertent administration of high-concentration heparin and to mitigate resulting harm. These include reviewing storage areas for look-alike products, implementing differentiation strategies (e.g., different heparin formats for different uses [line flushing, IV, subcutaneous administration]), segregating heparin flush preparations from other heparin products, and reducing the number of products stored in patient care areas.

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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.ismp-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:
https://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.

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