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ISMP

Acute Care
ISMP Medication Safety Alert!®
Educating the Healthcare Community About Safe Medication Practices

Medication errors during insulin administration for patients with hyperkalemia

Hyperkalemia is a serious, potentially lethal electrolyte disturbance that requires medical treatment without delay if it is severe enough to cause disturbances in cardiac conduction. Although hyperkalemia treatment guidelines in the literature vary,[1] many organizations begin treatment with the administration of one or more intravenous (IV) bolus doses of 50% dextrose and an IV bolus dose of 10 units of insulin. Some organizations use a rapid-acting insulin (i.e., insulin aspart, insulin lispro) rather than short-acting insulin (i.e., regular insulin) because it may decrease the incidence of hypoglycemia, given its shorter half-life.[1]

Errors When Treating Hyperkalemia

When treating hyperkalemia, the potential for errors and patient harm is significant due to the urgency of the treatment, the difficulty in measuring and administering bolus doses of IV insulin, and the risk of treatment-induced hypoglycemia. A 2017 analysis of almost 200 adverse events associated with hyperkalemia treatment showed that delayed treatment and administration of insulin by the wrong route or the wrong dose (mostly overdoses) were the most common types of errors.[1] The analysis also showed that, despite the administration of dextrose, hypoglycemia was still a relatively common occurrence often linked to the variability in dextrose and insulin dosing, the type of insulin used, duration of the dextrose and insulin infusion, the sequence of administering the dextrose and insulin, and patient factors such as renal dysfunction. Some episodes of hypoglycemia have also been caused by administering only the insulin portion of the treatment and not the glucose component.[2]

Causes of Errors

Delays. Most delays have occurred because treatment was postponed until patients were transferred to another unit, or there were no immediate signs of changes on a patient's electrocardiogram (EKG). Although the effects of hyperkalemia can be de-

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SAFETY briefs

Unreadable glass ampuls. A hospital pharmacist told us that he received a supply of clear glass ampuls of dimercaprol (**BAL IN OIL**) 300 mg/3 mL manufactured by Akorn (dimercaprol is an antidote given to treat arsenic, gold, mercury, and lead poisoning). When he went to scan the barcode to add the product to inventory, he found it could not be read because the dark print on the clear glass was not recognized by the scanner (**Figure 1**). There is also overlapping text that can be seen through the glass, which may have interfered with readability by the scanner. Looking at the photo, it appears that people also would not be able to read the label very well.

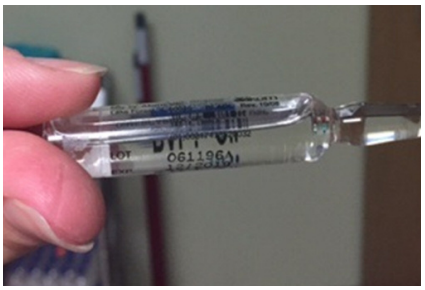

Figure 1. Label is nearly unreadable on the ampul.

Healthcare professionals would be best served if ampul dosage forms were avoided whenever possible. A US Food and Drug Administration (FDA) draft guidance states

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Apply now for an ISMP fellowship

ISMP is accepting applications until **March 31** for two unique yearlong fellowship programs commencing mid- to late-summer 2018:

- The **ISMP Safe Medication Management Fellowship** offers a pharmacist, nurse, or physician an opportunity to learn from the nation's experts in medication safety at the Horsham, PA, office of ISMP.

- The **FDA/ISMP Safe Medication Management Fellowship** offers a healthcare professional an opportunity to work with medication safety experts at ISMP in Horsham, PA, for 6 months, and the US Food and Drug Administration (FDA) Division of Medication Error Prevention and Analysis in Silver Spring, MD, for 6 months.

All candidates must have at least 1 year of postgraduate clinical experience and relocate to the area. For details, visit: www.ismp.org/profdevelopment/.

Take our NEW FOLLOW-UP survey on smart pump data usage

ISMP is conducting a follow-up survey on smart infusion pumps, this time focusing on your views about infusion pump data and how you may be using the data to improve compliance and safety. Like the results of our other recent surveys on smart pumps, we plan to use the results of this survey to update and develop guidelines to maximize safety with smart pump technology. See **page 5** to preview the survey questions. Please submit your responses online by **March 30** at: www.ismp.org/sc?id=3096.

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tected on an EKG as peaked T waves, a prolonged PR-interval, and a widened QRS-interval,[1] an EKG is a poor indicator of hyperkalemia severity; thus, patients with hyperkalemia who meet criteria for treatment based on their potassium level should be treated without delay even in the absence of EKG changes, because even benign changes can quickly progress to lethal arrhythmias.[3]

Wrong route. Some insulin wrong route errors have occurred during order entry when IV insulin was prescribed by the subcutaneous route. This was sometimes caused by an automatic default to the subcutaneous route for routine insulin prescribed outside of standard order sets that had been developed for IV insulin. In these cases, the prescriber did not use the hyperkalemia order set to prescribe the insulin, or no such order set existed. In other cases, the IV insulin was mistakenly administered subcutaneously, perhaps because it was a more familiar route of administration. Insulin should be given IV when treating hyperkalemia to promote consistent bioavailability.[1,4]

Dosing errors. Most dosing errors have involved measuring insulin doses in mL instead of units (e.g., 10 mL instead of 10 units), misreading the measurement markings on syringes, and not understanding the differences between insulin syringes and other parenteral syringes. Some dosing errors have occurred because practitioners failed to recognize that the U-100 strength of insulin equates to 100 units in each mL, and they were either practicing outside of their scope of practice or had never been taught to administer insulin IV.[2,3] Providing the required insulin in vials rather than the exact dose, particularly without directions for measuring the dose, has also contributed to errors. In a 2011 analysis, we found that human error (e.g., mental slips, lapses, forgetfulness) associated with insulin dose measurement and hyperkalemia treatment was a predominant cause of dosing errors.[2]

However, at the crux of many of these errors is the lack of a luer-compatible insulin syringe without a needle that can be used to measure and administer IV insulin via needleless access devices and lines. Most insulin syringes in hospitals have an attached needle appropriate for subcutaneous administration of medications. Also, some hospitals are only using insulin pens, which are likewise an inappropriate device to measure and administer IV insulin doses via a needleless system. This has resulted in several unsafe practices, including: 1) distribution of hyperkalemia treatment kits that, instead of insulin syringes without a needle, contain a tuberculin syringe and vial of rapid- or short-acting insulin; 2) calculating the volume of insulin needed for each dose so a luer-compatible (non-insulin) syringe can be used for administration, which has resulted in calculation and measurement errors; and 3) measuring doses in an insulin syringe, and then transferring the dose to a parenteral syringe for IV administration, which can lead to dose inaccuracies and infection control breaches.

Examples of Recent Errors

Several recent insulin errors during hyperkalemia treatment have been reported to ISMP or have appeared in the literature. For example, just this month, we learned about an error in which a nurse correctly calculated the volume needed for a 10 unit dose of insulin lispro, but accidentally measured out 20 units of insulin using a 10 mL non-insulin syringe. A physician prescribed treatment that included calcium gluconate 1 g IV, insulin lispro 10 units IV, and dextrose 50% IV. The nurse calculated that she would need 0.1 mL of the insulin for the 10 unit dose, and a nurse manager verified the calculation. Using a 10 mL syringe, she drew the insulin lispro into the syringe up to the first gradation mark, believing this represented 0.1 mL. But the first syringe marking was actually 0.2 mL. The nurse manager did not verify the dose in the syringe prior to administration. The error was quickly discovered when a clinical nurse specialist asked the nurse, who had just completed orientation, to

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that, "Product container labels and carton labeling should communicate information that is critical to the safe use of a medication from the initial prescription, to procurement, preparation and dispensing of the product to the time it is given to the patient." Poor label design can contribute to medication errors by making it difficult for healthcare professionals, caregivers, and/or patients to readily locate and understand critical safety information. At a minimum, if manufacturers must make medications available in ampuls, FDA should require identification of the drug, strength, barcode, lot number, and so on, to be printed in contrasting ink on a paper or ceramic background. We spoke with Akorn, and the company confirmed it is using a clear label on the ampul but is now checking options to improve label readability. If you run across any other poorly labeled products, please let us know.

Label improvements needed for iron products. A practitioner reviewing an elderly patient's home medication list learned that the patient's daughter had been giving him 5 tablets of ferrous sulfate daily to equal the 325 mg dose recommended by her father's physician. The ferrous sulfate she had purchased at a pharmacy was only labeled with the amount of elemental iron in each tablet, 65 mg. The label provided no indication that each tablet was equivalent to ferrous sulfate 325 mg. The patient's daughter thought she was supposed to give her father five 65 mg tablets for each 325 mg dose. The patient experienced severe constipation and stopped taking the iron after 2 days but was soon hospitalized for other reasons, where the error was discovered.

This is not a new problem. Longstanding lack of standardization for iron product labeling has led to frequent dispensing and administration errors. A total of 67 reports concerning iron were submitted to the ISMP National Medication Errors Reporting Program (MERP) between 1998 and 2017. Forty percent of these reports were due to confusing product labeling on both the outer package and individual unit doses.

Providers often order iron based on the salt form (e.g., ferrous sulfate 325 mg daily). Yet the container labels of some iron products express only the amount of elemental iron

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demonstrate how she had measured the insulin dose in a 10 mL syringe. The patient's blood glucose was monitored, and she experienced no adverse effects.

Another event appeared in recent literature involving a medical resident working in interventional radiology (IR) who gave the wrong dose of insulin to a hemodialysis patient with hyperkalemia.[3] The hospitalized patient was scheduled for replacement of her dialysis access in IR. On the day of the procedure, her potassium level was 5.9 mmol/L, and she was treated with **KAYEXALATE** (sodium polystyrene sulfonate). A repeat potassium level was drawn, and the result, 6.9 mmol/L, was reported to IR during the procedure. Because the patient was stable without EKG abnormalities, treatment was delayed until after the procedure.

When the procedure had been completed, a resident went to the pharmacy to request the medications needed for hyperkalemia treatment, including 10 units of regular insulin. The pharmacy dispensed a 3 mL vial of U-100 regular insulin without clarification that only 0.1 mL would be needed for a 10 unit dose. The resident mistakenly administered the entire vial of insulin (300 units) instead of 10 units. He had little prior experience measuring and preparing insulin doses since medication administration of this type was not within his scope of practice.

When the dosing error was identified, a rapid response team was called. The patient was treated with a 10% dextrose infusion along with 4 bolus doses of 50% dextrose in the first 30 minutes, and then dialysis. The patient was transferred to an intensive care unit (ICU) and able to tolerate meals with carbohydrates to provide a more physiological delivery of glucose. Glucose and potassium levels stabilized, and the patient was transferred out of the ICU within 2 days.

Recommendations

Treatment protocols. Establish standard hyperkalemia protocols that specify the threshold for treatment based on severity (e.g., potassium level above which to act), the corresponding pharmacological and clinical interventions, and monitoring parameters to gauge the patient's response to the treatment. Ensure adequate monitoring of glucose levels and signs and symptoms of hypoglycemia during treatment, even if dextrose is being administered, and for several hours after insulin administration. Hypoglycemia may occur up to 6 hours after dextrose and insulin administration, especially if the patient has renal dysfunction.[1,5]

In the protocols, also specify the insulin type, dose, and route of administration, and how to flush the IV line or access site, if necessary, to ensure the small volume of insulin has been fully administered; the concomitant dextrose concentration, volume, and route of administration; and specific doses and administration for all other pharmacological interventions (e.g., sodium bicarbonate, calcium chloride/gluconate, furosemide).

Standard order sets. Create standard order sets for hyperkalemia treatment and require their use. Treatment should only be prescribed using a standard order set that is automatically populated with the correct dose and route of administration for the required medications, including insulin. If the insulin dose is to be administered IV push via a syringe, include on the order set a reminder to use a luer-compatible insulin syringe without a needle, and to flush the line or access site if necessary to ensure the small volume of insulin has been fully administered. These reminders should also appear on the medication administration record.

Treat at threshold. Do not delay treatment of hyperkalemia based on the absence of symptoms or EKG changes once an established severity threshold for treatment has been reached. If transfer to another unit is necessary, accomplish the handoff as soon as possible so treatment can begin.

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in each tablet. Other iron products express the amount of iron in salt form on the primary display panel and a differing amount of iron, the elemental form, in the Supplement Facts panel (**Figure 1**). Over-the-counter iron products are regulated as food supplements, so a Supplement Facts panel appears on the

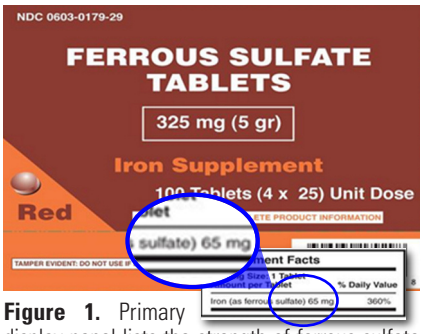

Figure 1. Primary display panel lists the strength of ferrous sulfate as a salt, while the same product's Supplement Facts panel lists the strength as elemental iron.

label instead of a Drug Facts panel. Listing the apothecary strength (5 gr) can also lead to confusion. Some iron supplements do not include the amount of iron on the primary display panel and instead list the dose of elemental iron only on the Supplement Facts panel (**Figure 2**). In the latter example, one must search under the ingredients section to find that the iron is from ferrous sulfate. ISMP has discussed this issue with the US Food and Drug Administration Center for Food Safety and Applied Nutrition.

Figure 2. FER-IN-SOL front panel label lacks any mention of strength, while the Supplement Facts label lists only the amount in terms of elemental iron.

Sterile water shortage. Hospitals struggling with the Sterile Water for Injection shortage should be aware of a media announcement released last week from the American Society of Health-System Pharmacists that discusses various options to help cope with the situation. The document can be found at: www.ismp.org/sc?id=3092.

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Pharmacy preparation or kits. Have pharmacy prepare, label, and dispense IV insulin doses in a ready-to-use form, either in a luer-compatible insulin syringe that can connect to a needleless system, or diluted in a small minibag. Although hyperkalemia is a medical emergency, the administration of insulin, in most circumstances, can wait until a pharmacist prepares a stat dose. If 24-hour pharmacy service is not available, stock hyperkalemia treatment kits on patient care units in automated dispensing cabinets (ADCs). The kits should contain 50% dextrose injection along with a 3 mL vial of rapid- or short-acting insulin (to lessen the potential amount of insulin a patient could receive in error), a luer-compatible insulin syringe, a removable needle or transfer device to withdraw the insulin from the vial to the syringe, a label for the syringe (to apply after preparation but before administration), a vial or syringe of a compatible flush solution, alcohol swabs, and directions for preparing and administering the dose. Other medications needed for hyperkalemia treatment can typically be obtained from a code cart or ADC but may be provided in the kit if necessary.

Luer-compatible insulin syringes. Carefully evaluate whether luer-compatible needleless insulin syringes are needed in certain patient care units (e.g., critical care, emergency department). BD and Monoject offer these syringes; for an example, see: www.ismp.org/sc?id=3095. Due to the risk of inadvertent use for subcutaneous insulin doses that could then be accidentally administered IV, limiting use of these syringes for pharmacy-dispensed insulin doses or in hyperkalemia kits is preferred. If the syringes are made available in certain units, separate their storage from other insulin and parenteral syringes (e.g., stock only in code carts, away from other syringes) so they are less likely to be inadvertently mixed up, and ensure they are not automatically removed from stock due to low use.

Double check. Require an independent double check of all IV insulin doses to confirm the patient and the insulin type, concentration, dose, amount in the syringe, route of administration, and indication prior to administration.

Education. Provide education to all practitioners and students who might prescribe, dispense, and administer medications used to treat hyperkalemia, including IV insulin. Don't assume that all practitioners are knowledgeable and skilled with measuring doses and administering IV insulin. Cover the types and concentration of insulin used during treatment, recognition of safe dosage ranges, the availability of luer-compatible insulin syringes, the differences between insulin syringes and other parenteral syringes, how to measure insulin doses, and how to administer IV insulin. Clearly define the scope of practice for practitioners that allows or disallows IV insulin administration, and restrict insulin preparation and/or administration to those who have demonstrated competency.

References

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5) Apel J, Reutrakul S, Baldwin D. Hypoglycemia in the treatment of hyperkalemia with insulin in patients with end-stage renal disease. *Clin Kidney J.* 2014;7(3):248-50.

Special Announcements

ASHP Summer Meetings and The Great Safety Debate

ISMP and its Medication Safety Officers Society (MSOS) will again be sponsors of the *Medication Safety Collaborative* at the 2018 American Society of Health-System Pharmacists (ASHP) **Summer Meetings and Exhibition** on **June 2-6** in Denver, CO. We'll also be participating in **The Great Safety Debate**, where members from across the country meet on stage for a lively debate about top safety concerns. We'll have three teams, with involvement of a medication safety resident or fellow, a nurse, and a pharmacist. The debate topics being considered include: internal versus outsourced "meds to beds" programs, employee drug testing, and responsibility for opioid stewardship. Being involved in the debate is a great way for you to share your expertise and collaborate with others. To learn more, and if you would like to nominate yourself or someone else to participate in the debate, please notify Michael Dejos, the Medication Safety Officer at Nemours/Alfred I. duPont Hospital for Children in Wilmington, DE, at: michael.dejos@nemours.org. The deadline for joining the debate is **February 15**.

Do a "rotation" at ISMP

Spend a week at ISMP during the **March 5-9 Practitioner in Residence** program to get help with specific organizational challenges and plan high-leverage safety initiatives for your organization. To learn more, call Michelle Mandrack at: 215-947-7797, or send an email to: mmandrack@ismp.org.

"Intensive" training in medication safety

The last **Medication Safety Intensive (MSI) Workshop** sold out quickly! Act now to avoid being put on the waiting list for our **April 5-6** workshop in **Philadelphia**—you won't want to miss this unique opportunity to maximize your error-prevention efforts. For details, please visit: www.ismp.org/ sc?id=637.

ISMP INSTITUTE FOR SAFE MEDICATION PRACTICES

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Report medication and vaccine errors to ISMP: Please call 1-800-FAILSAF(E), or visit our website at: www.ismp.org/MERP or www.ismp.org/VERP. ISMP guarantees the confidentiality of information received and respects the reporters' wishes regarding the level of detail included in publications.

ISMP Follow-Up Survey on Smart Pump Data Usage

ISMP is conducting a **NEW FOLLOW-UP survey** on smart infusion pumps, this time focusing on practitioners' views about infusion pump data and how they may be using the data available with smart infusion pumps to improve compliance and safety. The survey is open to practitioners who use smart infusion pumps, regardless of whether you have participated in our prior recent surveys on the topic. For the purpose of this survey, smart pumps are defined as: programmable pumps with dose-error reduction software. Please complete the survey and submit your responses to ISMP by **March 30, 2018**, via our secure web-based portal at: www.ismp.org/sc?id=3096. Thank you for participating in our survey!

Demographics

1 **Please select the best responses that describe your practice setting, number of licensed beds, and professional discipline.**

Practice setting: ☐ Hospital ☐ Ambulatory surgery center ☐ Ambulatory infusion center ☐ Other (please specify):_____

Licensed beds: ☐ NA (e.g., ambulatory center) ☐ Up to 25 ☐ 26-99 ☐ 100-299 ☐ 300-499 ☐ 500 and over

Professional discipline: ☐ Nurse/advanced practice nurse ☐ Pharmacist ☐ Physician ☐ Anesthesia provider

☐ Patient/medication safety officer ☐ Risk/quality/safety professional ☐ Other (please specify): _____

2 **Do you participate in the review of available data from your organization's smart infusion pumps?** ☐ Yes ☐ No

Data Analytics

3 **Does your organization provide dedicated resources for reviewing infusion pump data?**

Dedicated time? ☐ Yes ☐ No ☐ Don't know **Dedicated staff?** ☐ Yes ☐ No ☐ Don't know

4 **Do you believe reviewing infusion pump data is an essential part of your organization's quality improvement practices?**

☐ Yes ☐ No ☐ Don't know

5 **How often does your organization review data available from your smart infusion pumps?**

☐ No available data ☐ Data not reviewed ☐ Don't know ☐ Less often than yearly

Thank you for participating in our survey!

☐ No defined frequency but more than yearly ☐ Yearly ☐ Every 6 months ☐ Quarterly ☐ Monthly ☐ Weekly ☐ Daily

6 **Is infusion pump alert data part of your organization's larger initiative to reduce alert fatigue?**

☐ Yes ☐ No ☐ Don't know

7 **On average, how much time does your organization spend on smart infusion pump data review each month?**

☐ Less than 2 hours ☐ 2 to 8 hours ☐ 9 to 16 hours ☐ More than 16 hours

8 **What are the key focus areas for your organization's smart infusion pump data review? (select all that apply)**

☐ Compliance with using the drug library ☐ Alert frequency ☐ Action taken in response to an alert

☐ Error/event/unexpected patient outcome investigation ☐ Good catches ☐ Other (please specify): _____

9 **With your smart infusion pump data, to what extent are you able to identify the following?**

a) Medications that have a low frequency of use but high rate of alerts ☐ Unable to identify ☐ Somewhat ☐ Fully

b) The top 10 medications by alert frequency ☐ Unable to identify ☐ Somewhat ☐ Fully

c) Risky practices (e.g., bedside dilution, nurse preparation of solutions) ☐ Unable to identify ☐ Somewhat ☐ Fully

d) The number and type of overridden alerts ☐ Unable to identify ☐ Somewhat ☐ Fully

e) Alerts due to exceeding low maximum concentrations or doses ☐ Unable to identify ☐ Somewhat ☐ Fully

10 **Does your organization participate in any collaborative smart infusion pump data analytic communities or obtain assistance from a pump vendor or external company to help analyze your data?** ☐ Yes ☐ No ☐ Don't know

11 **In the past year, has information learned from your pump data led to any of the following actions?**

☐ Update/change in the drug library ☐ Update/change in a policy, procedure, or practice ☐ Educational program

☐ Other (please specify):_____

12 **Do you believe that your organization has adequate time, expertise, and the necessary tools to fully extract meaningful conclusions from infusion pump data?** ☐ Yes ☐ Somewhat ☐ No ☐ Don't know

13 **What is the biggest challenge you face with analyzing smart infusion pump data in your organization?** _____