Preventing high-alert medication errors in hospital patients

We've made strides in preventing these errors but haven't reached our goal.

By Pamela Anderson, MSN, RN, APRN-BC, CCRN, and Terri Townsend, MA, RN, CCRN-CMC, CVRN-BC

MISTAKES involving medications are among the most common healthcare errors. Medication errors lengthen hospital stays, increase inpatient expenses, and lead to more than 7,000 deaths annually in the United States. Each error costs an estimated $2,000 to $8,750. An error can happen in the home or a healthcare facility; this article focuses on errors in hospitals.

While any medication potentially can cause harm, a select group of drugs—high-alert medications (HAMs)—carries a higher risk of patient injury. According to The Joint Commission (TJC), HAMs frequently are associated with harm, the harm they cause is serious, and when they're misused, the risk of serious injury or death is high. Even when given correctly, these drugs carry a significant risk of causing harm. The Institute for Safe Medication Practices (ISMP) describes HAMs as drugs "that bear a heightened risk of causing significant patient harm when… used in error."

HAMs share several characteristics—a narrow therapeutic index and the risk of significant harm if the wrong route is chosen or a system failure occurs. Drugs with a narrow therapeutic index are dangerous because small changes in dosage or blood drug levels can lead to dose- or blood concentration-dependent critical therapeutic failures or adverse drug events. These adverse events are persistent, life-threatening, permanent, or slowly reversible and can lead to disability, the need for hospitalization, or death.

Organizations with guidelines on using HAMs include the ISMP, the Institute for Healthcare Improvement (IHI), and TJC. Some of these organizations also monitor errors involving HAMs. (See *Organizations that focus on medication errors.*)

The number of drug categories and specific medications identified as high alert varies with the agency or organization. All relevant organizations identify four specific HAM drug classes—anticoagulants, sedatives, insulins, and opioids—because they're frequently linked to potentially harmful outcomes. (See *Major adverse effects of high-risk medications.*)

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LEARNING OBJECTIVES

1. State the scope of the problem of errors associated with high-alert medications (HAMs).
2. Describe risks associated with the following classifications of HAMs: insulin, anticoagulants, opioids, and sedatives.
3. Discuss strategies to prevent errors associated with HAMs.

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Insulin errors

Reports received by ISMP reveal most insulin errors stem from human error (concentration lapses, distractions, and forgetfulness) related to dosage measurement and hyperkalemia treatment. Most of these errors stemmed from knowledge deficits—for instance, related to differences between insulin syringes and other parenteral syringes and the perceived urgency of treating hyperkalemia.

Here's an example: Treatment for hyperkalemic patients with renal failure may involve dextrose 50% injection (D50) and insulin to help shift potassium from the extracellular space to the intracellular space. This helps stabilize cardiac-cell membranes to allow time for other definitive treatments. In one error reported to ISMP, the physician prescribed 50 mL of D50 along with 4 units of regular insulin I.V. (U-100) for a patient with severe hyperkalemia and renal failure. The nurse mistakenly drew 4 mL (400 units) into a 10-mL syringe and administered it I.V. The patient suffered severe hypoglycemia.

Other reports involving hyperkalemia treatment indicate D50 wasn't given when the patient received insulin and became pro-

foundly hypoglycemic. Additional confusion can occur with U-500 insulin because it's given in a tuberculin syringe, not an insulin syringe. A patient who receives 150 units of U-500 twice daily should be taught to withdraw 0.3 mL insulin in a tuberculin syringe. Many patients and nurses mistakenly believe the patient's receiving 30 units of insulin, not 150 units.

Some insulin errors result from storing multiple concentrations and drug strengths next to one another, similar packaging of some drugs, and design flaws of certain insulin pens. With some pens, the user can easily misread the digital display of the dose when holding the pen upside-down. For example, a dose of 12 units might look like 21 units.

Anticoagulant errors

The most common anticoagulant errors are administration mistakes, including incorrect dosage calculation and infusion rates.

- Anticoagulants were linked to 59,316 errors reported to the United States Pharmacopeia MEDMARX registry from 2001 to 2006. Roughly 60% of these errors reached the patient, and about 3% caused death or harm.
- From January 1997 to December 2007, 446 medication-error sentinel events were reported to TJC's sentinel event database. About 7% were associated with anticoagulants; two-thirds of these involved heparin. Twenty-eight deaths occurred and six patients suffered loss of function.
- In 2005, enoxaparin was associated with four patient deaths and two cases of harm.

Errors involving newer anticoagulants

Since 2010, the Food and Drug Administration (FDA) has approved three target-specific oral anticoagulants. Unlike warfarin, which blocks multiple steps in the coagulation cascade, these newer anticoagulants block just one step. The first of these drugs, dabigatran, was approved in 2010 for stroke prevention in patients with nonvalvular atrial fibrillation and in 2014 for treatment of pulmonary embolism and deep vein thrombosis. Rivaroxaban was approved in 2011; apixaban, in 2012.

From October 2010 to December 2012, *QuarterWatch* (published by ISMP) noted an increased incidence of severe and fatal bleeding events in patients with a median age of 80. The FDA has received 7,387 reports of serious events associated with dabigatran, including 1,158 deaths. In 2014, the agency released new information revealing that although dabigatran is less likely than warfarin to cause intracranial hemorrhage, it's more likely to cause GI bleeding.

In the United States, many patients have switched from warfarin to dabigatran. However, no widely available laboratory test exists in this country to monitor dabigatran blood levels. In Europe and Canada, the hemoclot thrombin inhibitor kit assay determines thrombin clot-

Organizations that focus on medication errors

The Institute for Safe Medication Practices (ISMP) is a not-for-profit organization with more 30 years' experience in educating healthcare organizations and the public about safe medication use and error prevention. It routinely updates its list of high-alert medications (HAMs) based on errors reported to its National Medication Errors Reporting Program, harmful errors noted in periodic literature review, and feedback from clinicians and safety experts. Its List of High-Alert Medications in Acute Care Settings is available at www.ismp.org/tools/highalertmedications.pdf. According to ISMP, the top five high-alert drug classes are I.V. insulin, anticoagulants, chemotherapy agents, neuromuscular-blocking agents, and epidural and intrathecal medications.

The Joint Commission (TJC) has deemed safe medication use a national patient safety goal. TJC addresses specific concerns affecting patient safety. It recommends all healthcare organization establish a list of HAMs and develop policies for their use. Facilities can include medications from ISMP's high-alert drug list and add drugs to their list based on review of errors occurring in their facility. For example, after several fatal wrong-route errors occurred with Exparel, a liposomal form of bupivacaine whose packaging resembles that of propofol, several facilities are considering adding this drug to their high-alert list.

The Institute for Healthcare Improvement (IHI), also not-for-profit, aims to improve health and health care worldwide. IHI has published guidelines on how to reduce harm from HAMs. It lists insulins, sedatives, opioids, and anticoagulants as the top four high-alert drug classes.

HRET Implementation Guide

The Health Research and Educational Trust (HRET, a not-for-profit affiliate of the American Hospital Association) focuses on reducing harm related to HAMs by 50%. Its 2012 "Implementation Guide to Reducing Harm from High-Alert Medications" recommends the following interventions to achieve this goal:

- Assess awareness and readiness to change processes.
- Educate staff based on evidence and best practices.
- Use standardized order sets and protocols.
- Perform medication reconciliation at all transitions.

Standardization includes reducing variation in insulin sliding scales, coordinating insulin and meal times, and using protocols for withholding and restarting warfarin perioperatively. Including pharmacists on rounds can provide decision support for staff administering HAMs and reduce prescribing errors.

Another proven way to reduce medication errors is to hardwire failure-prevention interventions. Such interventions include automatic pharmacist notification when rescue medications are given and pharmacist monitoring of anticoagulants. For the complete implementation guide, visit www.ihconline.org/UserDocs/Pages/HRET_HEN_Change_Packages_AllMay2012.pdf.

Major adverse effects of high-risk medications

This chart shows major adverse effects of four categories of high-risk medications.

Drug category	Most common adverse effects associated with harm (or potential for harm)
Anticoagulants	• Major bleeding events, such as GI bleeding, intracranial hemorrhage, and retroperitoneal hemorrhage • Skin necrosis associated with warfarin
Insulins	• Hypoglycemia
Opioids	• Increased intracranial pressure in patients with head injury • Lethargy or somnolence • Oversedation • Profound hypotension • Respiratory arrest • Respiratory depression
Sedatives	• Confusion • Lethargy • Oversedation • Respiratory arrest • Respiratory and cardiovascular depression

ting time, which correlates to plasma dabigatran levels. Using this test would help clinicians identify patients at higher risk of bleeding.

Another disadvantage of the newer oral anticoagulants is lack of a reversal agent if catastrophic bleeding occurs. To help reduce bleeding risk during anticoagulation therapy, clinicians should use a calculator. (See *Online bleeding and stroke risk calculators.*) Before prescribing dabigatran, clinicians should weigh the patient's risks of bleeding and falling against the drug's potential benefits.

Opioid errors

Even when prescribed in appropriate dosages, opioids can cause harm. In 2013, the Society for Critical Care Medicine released new guidelines for the treatment of pain, agitation, and delirium. TJC periodically issues newsletters identifying important sentinel events and steps healthcare organizations should take to mitigate these events. An August 2012 sentinel evert alert reported that 47% of opioid-related adverse events in hospitals from 2004 to 2011 resulted from incorrect dosages, 29% from improper patient monitoring, and 11% from other factors (including drug interactions, excessive dosing, and adverse drug reactions).

Some hospital patients use patient-controlled analgesia (PCA) pumps to control pain. Based on reports submitted to the FDA Manufacturer and User Device Experience (MAUDE) database, PCA pumps carry a threefold higher risk of injury or death than general device infusion pumps. A review of the MAUDE database as of January 31, 2011, revealed 4,230 errors resulting in 826 injuries or deaths associated with PCA use, compared to 48,961 errors and 3,240 injuries or deaths associated with I.V. infusion pumps. Despite the greater number of errors with PCA use, the percentage of injuries associated with errors is three times higher with PCA pumps than with I.V. pumps (19% vs. 6.7%). The majority of these PCA errors stemmed from erroneous pump programming or using the wrong medication in the device. To improve PCA safety, many organizations use standardized pain medication order sets and dilutions for PCA medications. Some also use different order sets for opioid-naïve and opioid-tolerant patients.

Sedative errors

Sedatives, such as chloral hydrate and benzodiazepines, commonly are given for procedural sedation and during hospitalization. Inappropriate use can lead to oversedation, lethargy, hypotension, and delirium. Also, sedatives may increase the risk of falling. Sometimes, sedatives and opioids are administered together, with a synergistic effect that leads to central nervous system depression. The IHI publication "How-to Guide: Prevent harm from high-alert medications" describes results of periodic surveys of healthcare professionals conducted by ISMP. When asked about benzodiazepine use in elderly patients, many respondents said they consider this drug class to be high risk with this patient population.

In addition, sedatives may lead to harm if clinicians aren't familiar with the specific medication. For instance, they may titrate the dosage without knowing the upper dose limits, or they may be unaware of the drug's onset of action. Harm also may occur if the patient experiences respiratory depression or respiratory arrest in a facility without appropriate safety measures. The Minnesota Department of Health found approximately half of patients who fell and sustained serious injury were prescribed one or more problem medications associated with an increased risk of falling in the 24 hours preceding their fall. The most common problem medications linked to an increased fall risk were sedatives, opioids, antihypertensives, anti-anxiety drugs, and antipsychotics.

Prevention strategies

Research indicates nurses intercept 50% to 86% of medication errors before these errors reach the patient.

Online bleeding and stroke risk calculators

When administering an anticoagulant, you can use the online tools below to help determine your patient's risk for bleeding and stroke:

www.mdcalc.com/has-bled-score-for-major-bleeding-risk:
HAS-BLED score estimates major bleeding risk for patients on anticoagulation for atrial fibrillation.

www.mdcalc.com/hemorr2hages-score-major-bleeding-risk:
$HEMORR_2HAGES$ score quantifies hemorrhage risk in elderly patients with atrial fibrillation.

www.mdcalc.com/atria-stroke-risk-score:
ATRIA stroke risk score determines stroke risk in patients with atrial fibrillation.

In the hospital, medication delivery is a three-tiered process: a practitioner orders the medication, a pharmacist prepares it, and a nurse administers it. If the practitioner makes a mistake when ordering it, the pharmacist and nurse have a chance to intercept it. If the pharmacist makes an error in filling the order, the nurse has an opportunity to intercept it before it reaches the patient. Unfortunately, errors nurses make are likely to reach the patient.

IHI, ISMP, and other organizations recommend various strategies to reduce the risk of errors. One strategy involves multidisciplinary pharmacy and therapeutics committee teams with nurses and pharmacists working together. The Health Research and Educational Trust also has issued specific recommendations. (See *Web resources for clinicians.*)

Performing independent double-checks

Performing an independent double-check (IDC) helps ensure safe administration of HAMs. According to ISMP, IDCs can prevent up to 95% of errors before they reach the patient. In a properly conducted IDC, the second nurse verifies that the patient, drug, dosage, and route are correct and match the physician's order. In the scenario below, the second nurse caught her colleague's mistakes.

Nurse Laura is caring for a postoperative diabetic patient in the intensive care unit. When his blood glucose value soars to 472 mg/dL, she notifies the intensivist, who orders an insulin infusion and 10 units of regular insulin by I.V. push. Laura knows the insulin syringe has an affixed needle and the I.V. tubing has needleless ports. She draws up the insulin in a tuberculin syringe and asks another registered nurse to verify the dose, per hospital policy for high-risk medications. The second nurse notes that Laura has drawn up the wrong amount of insulin and is using a tuberculin syringe instead of an insulin syringe. She refuses to electronically sign the verification. If she hadn't caught Laura's mistakes, the patient would have received 1 mL of U-100 insulin, or 100 units I.V. push. As a result, the patient's blood glucose value would have dropped significantly, necessitating hypoglycemia treatment.

When nurses explain the IDC process to patients, the level of trust increases as patients witness the nursing staff taking measures to ensure their safety. So why don't all nurses perform IDCs if it's a proven way to reduce drug errors? ISMP research shows IDCs are time consuming. Medication administration already takes up about 25% of a nurse's typical shift. Also, with staffing shortages and increasing workloads, a second nurse may not always be available to perform an IDC.

What's more, not all electronic medication administration record (MAR) systems allow IDC documentation. Some organizations are using creative ways to rectify this situation. When staff at one Veterans Health Administration facility noted its electronic MAR didn't permit IDC documentation, they worked with the clinical documentation staff to make IDC documentation a "hard stop" with certain HAMs. Also, to speed the IDC process, they made personalized barcode identification cards for each nurse that can be scanned quickly instead of requiring manual entry for the second nurse's information.

Limiting interruptions during medication administration

Interruptions contribute to medication errors by disrupting the clinician's concentration and focus. In one study, the chance of making a medication error increased approximately 12% with each interruption during a single administration episode. The error rate doubled when four or more interruptions occurred. High workloads, high patient acuity, poor staffing ratios, and a chaotic environment contribute to interruptions and distractions.

A review of 54 studies on hospital medication administration errors found that in 16 studies, interruptions and distractions contributed significantly to errors. Wrong drug, wrong dosage calculation, and wrong administration time were common errors caused by interruptions. Lapses leading to omitting a drug dose may range from a minor delay (forgetting what the nurse intended to get from the medication cabinet) to a nurse thinking she gave a drug even though she didn't. Dangerous lapses include forgetting to discontinue an insulin infusion after an enteral feeding is halted and giving an I.V. push medication too rapidly, thinking it's the saline flush instead.

Several methods have been studied to decrease interruptions. In 1981, the Federal Aviation Administration instituted the "sterile cockpit" rule after it found nonessential conversations and interruptions contributed to some airplane crashes. Several hospitals

Web resources for clinicians

The websites below provide valuable resources to help reduce errors involving high-alert medications.

www.ihi.org/resources/Pages/Tools/HowtoGuidePreventHarmfromHighAlertMedications.aspx
Institute for Healthcare Improvement. How-to guide: Prevent harm from high-alert medications.

www.ihconline.org/UserDocs/Pages/HRET_HEN_Change_Packages_AllMay2012.pdf
Health Research & Educational Trust. Implementation guide to reducing harm from high-alert medications.

www.ismp.org
Institute for Safe Medication Practices

www.jointcommission.org/assets/1/18/SEA_49_opioids_8_2_12_final.pdf
The Joint Commission. Sentinel Event Alert. Safe use of opioids in hospitals.

have applied portions of the sterile cockpit rule to nursing units and medication administration procedures. One hospital created a no-interruption zone by encircling the area around the medication cart with red tape to indicate nurses inside the red zone weren't to be interrupted. Over a 3-week period, interruptions decreased by 40.9%. In some hospitals, nurses administering medications wear yellow or red vests to serve as a visual reminder to others not to interrupt them. Also, hospitals can place warning signs on medication-dispensing machines and medication carts to limit distractions.

One nursing unit determined interruptions during medication administration came primarily from patients' families, transporters, physicians, and telephone calls. They limited communications during medication administration by screening telephone calls and placing removable warning signs on medication carts during medication administration.

Reducing confusion around drug names

Many drug names look or sound like those of other drugs. Confusing drug names are a leading cause of medication errors. Several HAMs are on ISMP's confused-drug name list, including these drug pairs:

- Diprivan/Diflucan
- dobutamine/dopamine
- epinephrine/ephedrine
- heparin/Hespan
- Humulin/Humalog
- hydromorphone/morphine
- Lantus/Latuda
- Levemir/Lovenox
- lente/Lantus
- Pavulon/Peptavlon. (For the complete list, visit www.ismp.org/tools/confuseddrugnames.pdf.)

Strategies for reducing errors related to look-alike, sound-alike, or confusing medications include using tall-man lettering (such as DOPamine and DOBUTamine) and separating the pairs in dispensing machines and on storage shelves.

Similar packaging from one drug to another, and even from one dosage strength to another, also causes confusion that can lead to medication errors. Here's an example:

While caring for Morris Wilson, age 72, Nurse Jessica notices his heart rhythm has suddenly changed to ventricular tachycardia. She reaches into the medication cabinet and grabs a prefilled lidocaine syringe in a red and white box. In her haste, she has mistakenly picked up the 1-g box instead of the 100-mg box. As she pushes the last of the lidocaine into Mr. Wilson's I.V. line, she realizes her mistake. Unfortunately, he suffers cardiopulmonary arrest and requires resuscitation.

In this example, the 1-g and 100-mg dosage forms came in look-alike packages and were stored side by side. After the incident, staff requested the hospital obtain premixed infusions and remove the higher-dose lidocaine from the unit stock to help prevent similar errors.

A goal within reach

In the 15 years since the Institute of Medicine (IOM) published *To Err Is Human: Building a Safer Health System*, medication errors remain near the top of the list of harmful events for hospital patients. Such errors persist even after the IOM's 2006 report *Preventing Medication Errors* found medication errors harm 1.5 million patients each year. Interventions designed to reduce or eliminate interruptions during medication administration have been shown to reduce errors—but only when staff use them properly.

Standardization of drug labeling, storage, concentrations, and dosages has significantly decreased errors involving HAMs. IDCs and barcode scanning have helped, too. Combining multiple strategies can reduce errors even further. Staff education and buy-in are important to ensure compliance with error-reduction strategies and overall success of interventions.

Understanding the medications we administer and the correct way to administer them are vital to preventing errors. While great strides have been made in error prevention, we still haven't reached our goal—to make HAM errors "never" events. With vigilance, knowledge, standardization, and automatic safeguards, we can achieve our goal and ensure safety for the hospital patients in our care. ✭

Visit www.AmericanNurseToday.com/?p=19938 for a list of selected references.

Pamela Anderson is a nurse practitioner for the peripheral vascular surgeons of St. Vincent Physician Network in Indianapolis, Indiana. Terri Townsend is a medical-surgical staff educator for Community Hospital Anderson in Anderson, Indiana.

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Please mark the correct answer online.

1. Each year, medication errors lead to how many deaths in the United States?
a. 1,000
b. 3,000
c. 5,000
d. 7,000

2. Each medication errors costs approximately:
a. $1,000 to $5,550.
b. $1,500 to $7,400.
c. $2,000 to $8,750.
d. $2,000 to $10,230.

3. Which of the following statements related to HAMs is correct?
a. HAMs have a wide therapeutic index.
b. HAMs have a narrow therapeutic index.
c. HAMs encompass two drug classes.
d. HAMS encompass six drug classes.

4. Which statement about U-500 insulin is correct?
a. A patient who withdraws 0.3 mL of U-500 insulin in an insulin syringe will receive 50 units of insulin.
b. A patient who withdraws 0.3 mL of U-500 insulin in a tuberculin syringe will receive 30 units of insulin.
c. The patient should draw up U-500 insulin in an insulin syringe.
d. The patient should draw up U-500 insulin in a tuberculin syringe.

5. Which statement about risks associated with dabigatran is correct?
a. It carries a higher risk of intracranial hemorrhage than warfarin.
b. It carries a lower risk of GI bleeding than warfarin.
c. No reversal agent is available in case catastrophic bleeding occurs.
d. A reversal agent is available in case catastrophic bleeding occurs.

6. The most common cause of adverse effects related to opioids is:
a. incorrect dosage.
b. improper patient monitoring.
c. drug interaction.
d. excessive dosing.

7. Which statement about sedatives is accurate?
a. Sedatives and opioids sometimes are given together, which can lead to central nervous system (CNS) depression.
b. Sedatives and opioids sometimes are given together, which can lead to CNS stimulation.
c. Sedatives can lead to hypertension when used inappropriately.
d. Sedatives can lead to hyperactivity when used inappropriately.

8. Which statement about independent double-checks (IDCs) is correct?
a. All electronic medication administration systems permit IDC documentation.
b. IDCs do not add time to medication administration.
c. When an IDC is done correctly, the second nurse verifies that the patient, drug, dosage, and route are correct and match the physician's order.
d. When an IDC is done correctly, the second nurse verifies that the patient, drug, dosage, and route are correct.

9. Which is NOT a valid strategy for reducing interruptions during medication administration?
a. Giving nurses mobile phones so they can quickly answer questions and return to medication administration
b. Placing tape on the floor to designate a no-interruption zone when nurses are administering medications
c. Having nurses wear colored vests to signal they are administering medications and shouldn't be interrupted
d. Placing warning signs on medication carts when medications are being administered

10. According to the Institute for Safe Medication Practices (ISMP), one of the high-alert drug classes is:
a. antibiotics.
b. I.V. insulin.
c. anti-inflammatories.
d. vitamins.

11. Which of the following is NOT a hardwiring failure-prevention method recommended by the Health Research and Educational Trust (HRET)?
a. Placing hard stops in the electronic medication administration record to allow documentation of independent double-checks
b. Pharmacist monitoring of anticoagulants
c. Automatic pharmacist notification when rescue medications are given
d. Making IDC documentation in the electronic medical record optional

12. Which of the following is a strategy that helps prevent HAMs?
a. Using tall-man lettering
b. Keeping similar-named drugs together on the shelf
c. Avoiding premixed infusions
d. Avoiding barcode scanning