



Fall 2006

Vol. 3, No. 3

Activity Development Team Disclosure: The following authors and reviewers involved in the planning of this activity have disclosed that they have no relevant financial relationships with commercial interests:

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- Michael J. Gaunt, PharmD, Author of "Errors with Epinephrine"
- Matthew Grissinger, RPh, Author of "Looking Beyond the Obvious Causes of Error"

Rethinking the Routine: Aspiration of Oral Contrast Solution with Bowel Obstruction

Objectives

Physicians participating in this activity will:

1. Assess the risk of oral contrast in patients with suspected small bowel obstruction.
2. Demonstrate knowledge of the recent guidelines from the American College of Radiology on imaging of patients with suspected small bowel obstruction.
3. Summarize how high grade obstruction of the small bowel is demonstrated on radiographic findings.

Need

In a recent report to PA-PSRS, a patient died following aspiration of regurgitated oral contrast given for a CT imaging study. According to recent guidelines from the American College of Radiology, the oral contrast may have been contraindicated for a patient with suspected small bowel obstruction.

A patient with a history of multiple abdominal operations came to the emergency department with abdominal pain, nausea, vomiting, and abdominal distension. The working diagnosis was bowel obstruction.

Intravenous fluids were started and dilaudid was given for pain control. An obstructive series was read as a bowel obstruction without evidence of free intra-peritoneal air. Following the results of the obstructive series, the surgical service was consulted for admission to the hospital. The surgeon on call requested, by phone, a CT scan of the abdomen and pelvis. A naso-gastric tube was inserted and approximately 800 mL of oral CT contrast solution was infused into the stomach over approximately one-half hour, after which the tube was clamped to prevent siphoning of the solution. The CT scan was done about an hour after the end of the infusion.

While having the CT of the abdomen and pelvis, the patient began gurgling and vomited. The patient was turned and physicians were called. This required one of the two attendants to leave the patient's bedside. On the physicians' assessment, the patient was poorly responsive. When the pulse ox monitor became available, the oxygen saturation was about 85 percent. The resuscitation was done, with the help of suction that had been brought into the room. A follow-up chest radiograph showed bilateral lower lobe infiltrates. The clinical diagnosis was aspiration of gastric contents into the lungs with hypoxia.



Vomiting and aspirating are not per se patient safety events. However, for a patient at risk for vomiting and aspirating, prevention and/or mitigation of at least the aspiration should be part of safe medical care. This patient had three commonly accepted indicators for being at greater than normal risk for aspiration of emesis: bowel obstruction with a full stomach, sedation from narcotics, and confinement in the supine position (during the CT scan). Facilities should be prepared to identify and respond to patients at risk for aspiration because of vomiting (or other risk factors, such as bleeding into the airway). For instance, if endotracheal intubation or monitoring or nursing accompaniment is not appropriate for an individual patient getting a CT scan with oral contrast, it might still be appropriate to:

1. Have a video monitor, as many CT scan rooms do, to display in the control room the parts of the patient not directly visible to the CT tech.
2. Have an emergency button available to providers within reach of the patient's head.
3. Have suction constantly available in the room near the CT scanner.
4. Train the CT technicians to identify and do emergency treatment for aspiration.

Of particular interest in this report is the "routine" use of oral contrast for a diagnostic CT scan of the abdomen and pelvis in a patient with prior clinical and radiographic diagnosis of bowel obstruction.

The American College of Radiology Committee on Appropriateness convened an Expert Panel on Gastrointestinal Imaging that developed Appropriate Criteria for Suspected Small Bowel Obstruction.¹ The criteria for this clinical condition were revised in 2005. The document is an excellent review of the subject that provides invaluable information to anyone considering imaging studies for such a patient. This guide states: "Patients with suspected high grade obstruction do not require additional oral contrast medium since the fluid in the bowel provides adequate contrast." On a scale of 1 (least) to 9 (most appropriate), the highest appropriate rating was given for CT of the abdomen and pelvis without oral contrast but with IV contrast (a rating of 8), followed by supine and upright abdominal x-ray (a rating of 7), then CT of the abdomen and pelvis with oral contrast and with IV contrast (a rating of 5). (One of the benefits of the patient not having a clamped naso-gastric tube during the CT is that the gastro-esophageal sphincter is not held open in a supine patient with a full stomach.) The literature, primarily from Indiana University, recommends that patients with signs of bowel obstruction on plain radiographs of the abdomen (air-fluid levels at differential heights in the same loop of bowel and mean air-fluid widths of at least 25 mm on upright abdominal radiographs) should not have oral contrast for clarifying CT scans of the abdomen and pelvis.^{2,3}

Facilities may wish to review their protocols for diagnostic imaging studies for patients with suspected small bowel obstruction in light of the recently revised Appropriateness Criteria from the American College of Radiology. They may also wish to review their ability to prevent and mitigate aspiration in all areas of their facilities where patients are at risk for this complication.

Notes

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Looking Beyond the Obvious Causes of Error

Objectives

1. Define latent failures and active failures and the role each plays when a medication error occurs.
2. Recognize that errors are caused by the combined effects of latent failures in the system and active failures by individuals.
3. List reasons that punishing individuals involved in errors is harmful to the entire organization.

Need

Many organizations take an ineffective approach towards reducing errors in health care. Investigations to find the “causes” of an error tend to focus on the “front end”, “sharp end”, or “active end” of the error--the frontline practitioner, such as the nurse administering the medication or the dispensing pharmacist. This article provides more effective approaches that consider contributing factors that can lead to medication errors that occur at the organizational level, known as the “latent end” or “blunt end” of an error. The role of latent failures in the medication system and active failures of individuals will be explained to explore how medication errors occur.

To truly understand the underlying causes that can lead to medication errors, we must first understand the medication use system. This system is a complex group of related processes that includes obtaining patient information, communicating drug orders, storage of medications, labeling and packaging of medications, patient education, medication administration, and environmental factors.

Medication errors are a property of this system as a whole, rather than purely the result of the acts or omissions of the people who interact with the system. Even when an error is due to the mistake of an individual, deeper investigation will likely determine that a variety of causes contributed to that individual’s perceived failure. Such causes could include:

- Poor order communication between the physician, nurse, and pharmacist.
- Dangerous medication storage practices.
- Look-alike packaging and labeling.¹

Unfortunately, when analyzing errors, some organizations tend to focus only at the active or “sharp end” of the error: the frontline practitioner most directly associated with it, such as the prescriber who wrote an order, the pharmacist who dispensed the medication, or the nurse who administered it. Some health care practitioners are taught early in their careers that they must be perfect—an unattainable and unrealistic expectation for any human.

When errors occur, the human tendency is to blame individuals. Those individuals blamed for the errors are considered to be inattentive, incompetent, lazy, or uncaring, and they are often subject to punitive action (Table 1) such as disciplinary action, private reprimands, remedial education (e.g., to follow the “5 rights”²), or termination. As a result, the practitioners involved may feel guilty and unworthy of their professional status.

In this type of environment, it’s not surprising that individuals may be tempted to hide future errors. In the end, punitive actions do little, if anything, to prevent the same error from happening again within the organization. It does nothing to focus attention on the most manageable component of an error: the system itself.



Effective analysis considers the latent failures that led to the error. Latent failures (also called contributing factors or “blunt end” failures) are weaknesses in organizational structures that support medication processes. These failures range from poor planning for an information management system to inadequate personnel training and education. Many of these failures are due to poor decisions made by management.³ By themselves, latent failures often are subtle and may not appear to directly cause an error. Their individual consequences are usually hidden, becoming apparent only when they occur together and in combination with failures or “slips” made by individuals at the “sharp end.”⁴ Examples of latent failures can be found in Table 2.

This medication error report submitted to PA-PSRS includes several latent failures that led to the wrong medication reaching a patient:

A nurse entered the organization’s automated dispensing cabinet (ADC) to obtain a 2 mg dose of morphine to be given intravenously to a patient. The ADC screen read “morphine sulfate 8 mg tubex.”

Instead of taking this dose and following the procedure for wastage, the nurse hit the override key and the screen then listed every type of morphine sulfate available. The nurse then selected the first medication listed at the top of the screen, which read “morphine sulfate 2 mg/mL.”

The drawer to the ADC opened, and the nurse removed the bottle. The bottle was unopened, and the nurse was unsure how to withdraw the medication. A second nurse told her to get a syringe and draw up one milliliter. The nurse administering the medicine noticed that the color of the solution was blue. The second nurse came back and asked, “Did you have to mix it?” The first nurse responded, “Oh no, I gave it intravenously.” The second nurse responded, “I thought you were giving it orally.”

Through our experience in reviewing medication errors, some possible contributing factors that led to this patient receiving an oral solution of morphine sulfate intravenously include the following:

- The strength of morphine available to the nurse was four times the dose needed. This led the nurse to seek another strength, since she was unwilling to waste the left over medication in the 8 mg tubex of morphine to administer the 2 mg dose.
- The list of medications that appeared on the ADC screen listed “every type of morphine sulfate available” instead of only those stocked in the ADC. In addition, all dosage forms of morphine were included (oral tablets, oral solutions, and injections).
- The description of the oral solution as “morphine sulfate 2 mg/mL” on the ADC screen did not indicate that this medication was an oral solution.
- The ADC was stocked with a multi-dose bottle of the oral morphine solution, instead of unit-dose cups.
- There was no pharmacy review of the order prior to administration of the medication.
- There was no independent double check of this high-alert medication while it was in the syringe to verify the correct dose prior to administration.
- Staff may have been unaware of the dangers of over-riding alerts or of high-alert medication procedures, such as an independent double check.

Reducing medication errors requires an effective, non-punitive reporting environment, an effective reporting system, and a multidisciplinary group to analyze the error reports. Armed with these tools, facilities can identify system deficiencies and make performance improvement changes to prevent harm to your patients. Without them, we are only addressing errors when they surface, rather than reviewing the cause. To proactively prevent errors from occurring in the future, they must be reported within your organization as well as to state reporting programs such as PA-PSRS and others, and the contributing factors need to be identified. A



cursory analysis focused on the front-line practitioner at the “sharp end” ignores the potential latent errors that can contribute to the same error recurring.

Organizations with an eye towards safety that encourage reporting of actual errors, “near misses” and even potentially hazardous conditions will gain rich information about the factors that may lead to an error.⁵ Where medication errors are concerned, the question of who was involved offers less information than what went wrong, how it happened, and why it occurred. A systems perspective begins with the assumption that errors will occur in the health care setting and that the multi-factorial nature of errors is system-based, not people-based. Most importantly, if we are going to strive to improve medication safety, we must focus on redesigning the system that may have led individuals down a path of failure.

Table 1. Examples of Punitive Approaches to Error Reduction

Private reprimand	Point system
Public reprimand	Errors recorded in performance appraisal
Written reprimand	Appearance before a peer review committee
Remedial education	Termination

Table 2. Examples of Latent Failures

Incomplete patient information, such as missing allergy or diagnosis information
 Unclear communication of a drug order
 Lack of independent double checks before dispensing
 Lack of computer warnings or alerts
 Ambiguous drug references
 Drug storage issues
 Unclear policies/procedures

Notes

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Let's Stop this "Epi"demic!—Preventing Errors with Epinephrine

Objectives

Physicians participating in this activity will:

1. Assess the risk of inadvertent IV administration of undiluted epinephrine.
2. Recognize the contributing factors to errors involving unintended IV administration of undiluted epinephrine.
3. Identify strategies to prevent inadvertent IV administration of undiluted epinephrine.

Need

PA-PSRS has received a number of reports involving errors with the high alert drug epinephrine. These reports describe situations in which clinicians administered by IV undiluted epinephrine (e.g., 1:1,000 [1 mg/mL]) rather than an appropriately diluted solution (e.g., 1:10,000 [0.1 mg/mL]). They also describe errors related to confusion between epinephrine and ephedrine resulting in inadvertent epinephrine administration. Unfortunately, when this occurs, the result to the patient is dramatic and life-threatening. This article provides strategies to address the system-related causes of inadvertent epinephrine administration.

The Pennsylvania Patient Safety Reporting System (PA-PSRS) has received numerous reports of accidental administration of concentrated epinephrine, a high-alert drug. While not more prone to error than other drugs, epinephrine does pose a greater risk of serious patient harm and death when used in error. Based on the reports submitted to PA-PSRS and elsewhere, the majority of the errors involving epinephrine can be traced to two problems: 1) expressing the concentration as a ratio strength rather than a metric per volume concentration; and 2) confusion between epinephrine and ephedrine.

Problem 1—Ratio Strength

Many epinephrine-related reports submitted to PA-PSRS describe situations in which clinicians administered undiluted epinephrine (i.e., 1:1,000 [1 mg/mL]) intravenously instead of a less concentrated solution (i.e., 1:10,000 [0.1 mg/mL]). Unfortunately, when this occurs, the result to the patient is dramatic and life-threatening, as can be seen in this example from PA-PSRS:

During a diagnostic bronchoscopy, the patient developed bleeding. Epinephrine was instilled to control bleeding, and the patient developed ventricular tachycardia and possible ischemic changes on EKG monitoring. Patient was stabilized and transferred to critical care. Initial cardiac enzymes were negative for myocardial infarction. On investigation, it was determined that the patient received the incorrect concentration of epinephrine. Measures are being undertaken to remove the incorrect concentration of epinephrine from the bronchoscopy set up to avoid a recurrence.

Often in situations like this, the more diluted epinephrine (1:10,000) is available for use, but staff inadvertently prescribe or select the 1:1,000 concentration. One such situation occurred in an outpatient radiology unit where the nurse rarely administered medications.¹ The patient developed hives and respiratory distress after



administration of contrast media. The physician prescribed 3 mL of the 1:10,000 concentration IV, but 3 mL of the 1:1,000 concentration was administered in error. The patient developed a rapid heart rate and increased blood pressure, requiring hospital admission.

More tragically, a 16-year-old boy was brought into the emergency department with priapism and died due to an epinephrine overdose.² A urologist ordered epinephrine, but he thought that the 1:1,000 ratio on the epinephrine 1 mg/mL label meant that the epinephrine had already been “prediluted” with 1,000 mL of fluid. The patient received 4 mL of 1:1,000 undiluted epinephrine injected into his penis. The patient arrested and died when the epinephrine reached his systemic circulation.

These errors highlight the problem of drug concentration presentation. The contents of most injectable medications are given as their mass concentration (mg or mcg per mL). Only a few drugs have concentrations expressed as a ratio or percentage. These expressions are error-prone because: 1) practitioners, even physicians and emergency medicine residents, may not recognize or understand the difference between dose concentrations, such as 1:1,000 or 1 mg/mL and 1:10,000 or 0.1 mg/mL³⁻⁵; and 2) it is easy to confuse numbers in the thousands because there are so many zeros (i.e., 1,000 looks like 10,000).

Most alarming, these poorly understood expressions are particularly prevalent with drugs used for resuscitation (e.g., epinephrine, lidocaine, sodium bicarbonate). An inappropriate dose or life-threatening delay in treatment is quite possible, especially if these drugs are prescribed in mg (which requires prior knowledge of ratio or percent concentrations and calculations) or mL (which is a problem if multiple concentrations exist).

Problem 2—Look-Alike Names: Epinephrine and Ephedrine

Another cause of errors involving epinephrine is confusion between epinephrine and ephedrine. Not only do these drug names look similar, but their use as vasopressors or vasoconstrictors makes storage near each other likely. Both products also may be packaged alike in 1 mL ampuls or vials.

In one case reported to PA-PSRS, a patient in the post anesthesia care unit (PACU) was prescribed ephedrine. However, the nurse inadvertently chose and administered epinephrine IV push. An ECG was performed, and the patient required a longer stay and further monitoring in PACU.

Another case involved a healthy young woman in a labor and delivery unit who became hypotensive after epidural anesthesia. A nurse called the obstetrics resident to inform him of the patient’s condition. The resident became irritated and ordered ephedrine 10 mg to be given slow IV push. The nurse, who was anxious because of the physician’s behavior, mistakenly processed the order as epinephrine. Because there was not enough epinephrine on the unit, she borrowed some from the nursery. She found a 30 mL vial of epinephrine 1:1,000, withdrew 10 mL (10 mg), and administered that amount to the patient. The patient developed tachycardia, severe hypertension, and pulmonary edema. Fortunately, an anesthesia staff member was present and recognized the problem immediately. The patient was treated successfully and the baby was delivered safely.⁶

Safe Practice Strategies

Because many of the emergency medications with concentrations expressed in ratios or percentages, including epinephrine, date back to before the 1938 Food Drug and Cosmetic Act, they do not fall under current FDA labeling standards. Epinephrine is a United States Pharmacopeia (USP) drug, subject to USP labeling requirements. Until USP eliminates the use of ratio expressions on epinephrine labels and changes the nomenclature to prevent confusion between epinephrine and ephedrine, consider these strategies as you strive to improve the safe use of epinephrine.



- Do not expect all health care practitioners to be familiar with percent or ratio expressions of concentrations, or to be adept at calculating doses for drugs with concentrations expressed in this manner.
- To the extent possible, use prefilled syringes and limit storage of concentrated epinephrine to crash carts (except in the ED and OR) to reduce the risk of dilution errors or administration of the wrong product.
- Store a single concentration wherever possible, and affix warning labels as appropriate to minimize confusion between the two concentrations of epinephrine.
- In units where multiple concentrations are needed (such as the ED), apply auxiliary warning labels to 1:1,000 ampuls to alert staff to the concentration in mg and to dilute it before IV use.
- Epinephrine 1:1,000 in 30 mL vials for systemic use presents a hazard and, at least in nurseries, should not be available on units. If this concentration is necessary, stock just the 1 mL ampuls so that the need for multiple ampuls can serve as an alert to the health care provider. If a 30 mL vial must be stored outside the pharmacy, alert staff about potential problems. Use auxiliary warning labels or circle "30 mL" to make the total volume more prominent.
- Post a dose conversion chart reflecting available concentrations on emergency carts and in other areas where these medications may be prepared.
- During annual CPR certification for clinical staff, review the dose chart and mention potential confusion with emergency drugs dosed in ratio or percent concentrations alone.
- Use "tall man" lettering to help differentiate EPInephrine from ePHEDrine. Consider using this on computer screens, pharmacy and nursing unit shelf labels and bins (including automated dispensing cabinets), pharmacy product labels, and medication administration records.
- Avoid storing epinephrine and ephedrine side-by-side.
- To ensure an independent double-check system, it would be best to have the pharmacy prepare all infusions and bolus doses for these drugs when possible.

Notes

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Editorial Policy

PA-PSRS Patient Safety Advisory (ISSN 1552-8596) is published quarterly, with periodic supplements, by the Pennsylvania Patient Safety Authority. This publication is produced by ECRI & ISMP under contract to the Authority as part of the Pennsylvania Patient Safety Reporting System (PA-PSRS).

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