Independent Double-Checks for Endogenous and Exogenous Errors

Matthew Grissinger, RPh, FASCP

Mr. Grissinger is a Medication Safety Analyst at the Institute for Safe Medication Practices in Huntingdon Valley, PA (www.ismp.org).

PROBLEM: What do the errors in the folowing cases have in common?

Case 1

A physician ordered a heparin infusion with directions to follow a weight-based nomogram for laboratory monitoring and dose adjustments. Later that evening, the nomogram indicated that an intravenous (IV) bolus dose of heparin 1,700 units should be administered based on the patient's activated partial thromboplastin time (aPTT) level.

The patient's nurse removed a 10-mL vial of heparin (1,000 units/mL) from an automated dispensing cabinet to prepare the dose. However, she miscalculated the volume that was needed as 17 mL, not 1.7 mL.

The nurse, concerned that she would be using a second vial of heparin to prepare the bolus, quickly asked another nurse to look at her math to make sure that she had not made an error. However, the other nurse did not actually recalculate the volume needed; she thus made the same error when looking over her colleague's work. The patient received 17,000 units of heparin. A physician's assistant discovered the error after the patient experienced severe epistaxis.

Case 2

An epidural infusion of fentanyl (2 mcg/mL) with bupivacaine 0.125% was started for a 62-year-old man who had just undergone a lobectomy for cancer of the lung. The drug was supplied as a premixed product manufactured by Baxter Compass.

Several nights later, a supervisor went to an automated dispensing cabinet to retrieve a replacement bag. However, she accidentally picked up a premixed Compass bag of morphine (1 mg/mL) intended for IV use. The bag was located in the same drawer as the fentanyl/bupivacaine bags. Both bags were packaged in identical brown plastic overwraps to shield the compounded solutions from light. The labels, located on one side of the brown overwraps, were also similar in appearance, and both products were packaged in the same-sized bags (100 mL in a 150-mL container).

The supervisor brought the bag to the nursing unit. A second nurse double-checked the product; however, she also failed to notice the mistake, because the bag was packaged in the brown overwrap, as she had come to expect.

The morphine was hung. Several hours later, the patient's respiratory status began to deteriorate and the epidural infusion was temporarily turned off. Even then, none of the staff members noticed the error. Another nurse, who was documenting the waste after the patient's epidural catheter was removed, finally discovered the error.

Although multiple system failures clearly contributed to these errors, in both cases, faulty double-checks allowed the errors to reach the patients.

Why did the double-checks fail? In part, the answer lies with how they were performed and with the differences between endogenous and exogenous errors.[1]

Case 1 (An Endogenous Error)

An endogenous error arises solely from within an individual, from a random and unpredictable cognitive event such as miscalculating a dose or prescribing a drug at a dose appropriate for the next medication being contemplated.

In Case 1, the nurse made an endogenous error when calculating the volume of heparin to administer. Because endogenous errors arise within a single person, another person performing the same function does not usually make the same error. Thus, endogenous errors can probably be detected if a double-check is performed independently by another person as a separate, redundant action. This way, the checker is not misled into the same faulty thinking as the person who originally made the error.

In Case 1, if the person performing the double-check had acted independently as a redundant function without prior knowledge of the first nurse's work, it is far more likely that the error would have been detected.

Case 2 (An Exogenous Error)

An exogenous error arises from conditions in the external environment, for example, poorly designed packages and labels, the complex nature of the task, or an unclear presentation of information. In this instance, the nurse made an exogenous error related to the look-alike packaging. A subsequent check by another nurse did not uncover the error.

Double-checks are often less successful in revealing exogenous errors, compared with endogenous errors, even when the check is performed independently. Some of the same external factors that initially led to the error may still be present, and employees with similar training can easily make the same mistake during the double-checking process.

SAFE PRACTICE RECOMMENDATION:

Here are some principles to help avoid errors in performing double-checks:

1. *The best advice is to avoid relying solely on double-checks.* Although double-check systems sometimes do fail—even more so with exogenous errors—they still play a vital role in error-detection strategies when they are placed at the most vulnerable points of medication use and when they are performed independently. However, the hoped-for improvement in system reliability is illusory if health care professionals rely on these manual double-check systems alone to catch all errors.

2. System changes must also be made to reduce the frequency of errors.

3. For the endogenous error in Case 1, system-based error-reduction strategies can be used to prevent calculation errors. For example:

a. dosing charts that eliminate the need for calculations.

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Figure 1 Appropriate labeling aids in reducing errors. Sameness distracts from label reading; auxiliary labels help to differentiate the products.

b. pharmacy preparation of non-emergency drugs.

4. For the exogenous error in Case 2, better labeling of the products is necessary, as follows:

a. The hospital that reported this error now applies large yellow labels that read "FENTANYL/BUPIVICAINE For Epidural Use Only" (to match the yellow stripe in the epidural tubing) or blue labels that read "CONTAINS MORPHINE Not for Epidural Use" on the bags (Figure 1) and on the overwraps.

b. The labels are applied to both sides of the bags and overwraps so that they can be seen, regardless of the bag's orientation in the pump or storage area.

c. The labels are also applied to the cartons stocked in the pharmacy.

d. The products are stored separately in both the pharmacy and in automated dispensing cabinets.

e. The pharmacy mandates that these look-alike products not be delivered on the same day in order to prevent mix-ups during the order-fulfillment process or upon receipt in the hospital.

REFERENCE

1. Senders J. Essays on human error in medicine. ISMP Canada, October 2000. Available at: www.ismp-canada.org/smp0010.htm. Accessed May 2, 2007.

The reports described in this column were received through the USP–ISMP Medication Errors Reporting Program (MERP). Errors, close calls, or hazardous conditions may be reported on the ISMP (www.ismp.org) or the USP (www.usp.org) Web site or communicated directly to ISMP by calling 1-800-FAIL SAFE or via e-mail at ismpinfo@ismp.org. ■