ABSTRACT

Of all care areas mentioned in medication error reports submitted from August 1, 2009, through July 31, 2010, to the Pennsylvania Patient Safety Authority, the emergency department (ED) is the third most commonly mentioned, appearing in 6% of all medication error reports. The predominant medication error event types in the ED include wrong dose/overdosage, drug omission, and wrong drug. The predominant classes of drugs mentioned in wrong-dose/overdosage error reports include antibiotics, steroids, anticoagulants/antiplatelet agents, and nonsteroidal anti-inflammatory agents. Possible risk reduction strategies include expanding the role of the pharmacy department in the ED’s medication-use process, limiting the number and variety of medications and concentrations available in the ED, and incorporating redundancies (e.g., order read-back) throughout the medication-use process. (Pa Patient Saf Advis 2011 Mar;8[1]:1-7.)

INTRODUCTION

Between 1996 and 2006, visits to U.S. emergency departments (EDs) increased by 32%, from 90.3 million to 119.2 million.1 During the same period, the number of EDs decreased approximately 5%. The disparity has contributed to crowding of EDs and boarding of patients waiting for admission or transfer. These quality issues, combined with a high volume of patients seeking episodic care for a range of acute and chronic illnesses and injuries, shortages of healthcare workers, and a complex healthcare environment, increase the potential for compromised patient safety in the ED.2 In addition, an inadequate information infrastructure across the care continuum often forces emergency providers to care for patients without all essential patient information.

One study (Santell et al.) of a national medication error database found that nearly 11,000 medication errors were reported over a five-year period by EDs in 484 unique facilities.3 Of these errors, 4.8% resulted in patient harm, including five fatalities. Drug administration was the most often reported phase of the medication-use process in which the error originated (45%), followed by prescribing (29%). Dispensing errors accounted for approximately 9% of the reported errors. A second, prospective, observational study was performed in a 40-bed, academic, tertiary ED with an annual census of approximately 70,000 patients to determine the rate and severity of medication errors, as well as common contributing factors associated with error occurrence. The study identified 178 medication errors in 192 patients. At least one error involved 59.4% of patients; 37% of patients overall had an error that reached them. No errors in the study resulted in permanent harm or contributed to initial or prolonged hospitalization; however, interventions performed to prevent harm likely influenced the severity of the errors. In contrast to the study performed by Santell et al.,3 the reported phase in which the error originated most often was prescribing (53.9%), followed by administration (34.8%), transcribing (10.7%), and dispensing (0.6%). The study concluded that medication errors in the ED are common, with errors occurring most often in the prescribing and administration phases.4 The results from the two studies may reflect the fact that the two phases of the medication-use process that occur most in the ED are prescribing and administration.

A possible contributing factor to medication errors in the ED is the unique medication distribution system used in this care area, which differs from that of the inpatient units. For example, medications in EDs may, when urgently needed, be retrieved from a non-pharmacy-profiled automated dispensing cabinet (ADC), unit stock, or refrigerator, and the prescriber’s order may not be reviewed by a pharmacist before the drugs are given.5

MEDICATION ERRORS IN PENNSYLVANIA EDs

Of all the medication error events that Pennsylvania healthcare facilities reported to the Pennsylvania Patient Safety Authority from August 1, 2009, through July 31, 2010, 2,569 occurred in the ED. In that period, the ED ranked as the third most commonly mentioned care area in which medication events occurred, cited in 6% of all medication error reports. Categorization of the reports by harm score, which is adapted from the National Coordinating Council for Medication Error Reporting and Prevention harm index,6 shows that 61.7% (n = 1,584) of the events reached the patient (harm index = C to I) and 0.6% (n = 18) of the events resulted in patient harm (harm index = E to I).

National data (1996 through 2006) shows that the age group with the highest annual per capita ED visit rate was infants younger than 12 months, at 84.5 visits per 100 infants (or about 3.5 million visits).1 Individuals aged 75 years and older had the second...
Drug Omission Errors in the ED

The drug classes most frequently mentioned in drug omission reports included antibiotics (26.4%, n = 93), anticoagulants (9.3%, n = 33), NSAIDs (5.9%, n = 21), and hypoglycemics (5.9%, n = 21). High-alert medications, drugs that bear a heightened risk of causing significant patient harm when they are used in error, included heparin, warfarin, enoxaparin (11.5%, n = 18), which represented more than half of all high-alert medications involved in omissions among the elderly (21.2% of omissions, n = 33).

Orders were written for adult deep venous thrombosis (DVT) prevention for Lovenox®. The patient was held in the ED overnight and sent to the floor the next day. The order for Lovenox was found the following day, and it was faxed to the pharmacy. The next day, a CT [computed tomography] scan of the chest showed pulmonary emboli. Orders [were written] to start heparin for pulmonary embolism/DVT protocol and the Lovenox was discontinued.

Only 25 reports (7.1%) of drug omissions involved the pediatric population, with the medications most frequently mentioned including albuterol (36% of pediatric omissions, n = 9) and ibuprofen (16%, n = 4).

Wrong-Dose/Overdosage Errors in the ED

The predominant classes of medications associated with wrong-dose/overdosage errors were similar to those associated with all event types combined, namely antibiotics (21.7%, n = 98), steroids (11.1%, n = 50), anticoagulants/antithrombotics (9.5%, n = 43), NSAIDs (7.7%, n = 35), and opioids (6.2%, n = 28). The most common medications mentioned in wrong-dose/overdosage reports are listed in Table 3.

While 24.1% (n = 109) of wrong-dose/overdosage events involved a high-alert medication, unlike the harm score breakdown for the overall data, only 33.8% (n = 153) of the events actually reached the patient and 0.9% (n = 4) harmed the patient. The four cases involving harm, described below, suggest problems related to inaccurate patient weight and the inappropriate use of HYDROMorphine (Dilaudid®), both of which have been discussed in past issues of the Pennsylvania Patient Safety Advisory.

Upon admission, the patient’s weight was estimated to be 100 kg. Based on that, a bolus of 8,000 units of heparin was administered along with an IV [intravenous] infusion of 20 units/kg/hr. The patient’s first heparin level came back at midnight at more than 1.10 and the patient was experiencing gross hematuria. Heparin was discontinued at that point to be reevaluated. It was then discovered that the actual weight of the patient was 90 kg, which represents a 10 kg (10%) difference in weight.

A patient arrived to the ED with complaints of abdominal pain. The patient was prescribed and given...
3 mg of IV Dilaudid over a three-hour period. The patient was found unresponsive and not breathing by a nurse. The patient was given Narcan® [naloxone] and was responsive with spontaneous breathing within minutes.

A patient went to the ED with flank pain due to a possible kidney stone. Dilaudid was ordered at 1 mg pm IV push × 3 doses. The patient continued to have pain. Dilaudid 1 mg IV now was ordered for three more doses as needed. The patient received a total of 6 mg of Dilaudid in less than three hours.

Patient seen in the ED for migraine headaches and was treated with Dilaudid 2 mg IM [intramuscular], was given a repeat dose of 2 mg IM and was discharged 40 minutes later in stable condition under the care of his daughter. The daughter at home became concerned and called EMS [emergency medical services]. EMS treated the patient with Narcan and the patient was brought back to the ED for evaluation and further treatment.

To guide appropriate drug therapy, healthcare providers need readily available patient demographic and clinical information (e.g., age, weight, allergies, diagnoses, pregnancy status) and patient-monitoring information (e.g., laboratory values, vital signs) that gauge the effects of medications on the patient’s underlying disease processes.10 Further analysis of wrong-dose/overdosage events in the ED shows that 28.5% (n = 129) of the event descriptions mention breakdowns in patient information, including errors involving patient weight (17.7%, n = 80), patient age (5.8%, n = 26), knowledge of existing medication profiles (2.7%, n = 12), the medication reconciliation process (2.2%, n = 10), and wrong patients (0.2%, n = 1). See the following examples.

An order was written for Decadron® 20 mg orally for an ED patient. The pharmacist missed the patient age and dispensed the order as written. After realizing the patient age, the pharmacist told the ED not to give Decadron until the pharmacist and prescriber could discuss the dose. The 20 mg dose was returned to pharmacy and the dose was changed to 2 mg (which is appropriate for a 24-month-old patient).

A baby came to the ED with a fever of 103°F rectally. The nurse gave 120 mg of Tylenol® [acetaminophen] to the baby. After giving the medication, she realized she did not convert the baby’s weight to kilograms prior to calculating dose.

Table 3. Predominant Medications Mentioned in Wrong-Dose/Overdose Events in Emergency Department (n = 175, 38.7%), August 1, 2009, through July 31, 2010

<table>
<thead>
<tr>
<th>MEDICATION PRESCRIBED</th>
<th>NUMBER</th>
<th>% OF TOTAL REPORTS (N = 452)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dexamethasone</td>
<td>32</td>
<td>7.1%</td>
</tr>
<tr>
<td>Heparin*</td>
<td>30</td>
<td>6.6%</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>20</td>
<td>4.4%</td>
</tr>
<tr>
<td>Tamiflu®</td>
<td>19</td>
<td>4.2%</td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>17</td>
<td>3.8%</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>15</td>
<td>3.3%</td>
</tr>
<tr>
<td>Ketorolac</td>
<td>12</td>
<td>2.7%</td>
</tr>
<tr>
<td>Prednisolone</td>
<td>10</td>
<td>2.2%</td>
</tr>
<tr>
<td>HYDROmorphine*</td>
<td>10</td>
<td>2.2%</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>10</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

* High-alert medications
Pediatric Wrong-Dose/Overdosage Errors

A retrospective cohort study by Kozier et al., conducted using the charts of 1,532 children to describe the incidence and type of drug errors in a pediatric ED, found prescribing errors in 10.1% (n = 154) of charts and drug administration errors in 3.9% (n = 59) of charts. The most common types of prescribing errors were dosing errors (49.1% of all errors), followed by drugs given with incorrect frequency (43.2% of all errors). The drug most frequently involved in errors was acetaminophen, followed by antibiotics, asthma medications, and antihistamines. These drugs were also the ones most often prescribed in that ED.11

Reports submitted to the Authority show that almost half (47.7%, n = 132) of the wrong-dose/overdosage events among the pediatric population (n = 277, 61.3% of all wrong-dose/overdosage errors) involved prescribing an excessive dose. The predominant medications were dexamethasone (11.6%, n = 32), Tamiflu® (6.9%, n = 19), ibuprofen (6.5%, n = 18), acetaminophen (6.1%, n = 17), and gentamicin (4.3%, n = 12).

In a retrospective review of medication errors in another pediatric ED, the incorrect documentation of patients’ weight, leading to incorrect dosing, was the most frequently reported error.12 Similarly, analysis of wrong-dose/overdosage events among the pediatric population (n = 277) reported to the Authority found that 21.3% (n = 59) involved a breakdown related to documented patients’ weight, while 9.4% (n = 26) involved a breakdown related to the patient’s age.

Pharmacy Interventions

One key healthcare practitioner that is often not a part of the medication-use process in the ED is the pharmacist. Historically, the role of the pharmacy in the ED has been limited to pharmacy technicians stocking ADCs, preparation of emergent IV solutions, and retrospective review of medication orders. However, organizations such as the Joint Commission now require more pharmacy involvement in this care area.13 According to an American Society of Health-System Pharmacists survey of 1,310 pharmacy directors in both general and children’s medical/surgical hospitals in the United States, 6.8% of hospitals have a pharmacist regularly assigned to the ED. Larger hospitals were more likely than smaller hospitals to have a pharmacist in the ED (54.2% of hospitals with 600 or more staffed beds had an ED pharmacist, compared to approximately 25% of hospitals with 300 to 599 staffed beds and less than 3% of hospitals with fewer than 300 staffed beds).14 The survey results also indicated that, overall, 44.4% of hospitals did not have pharmacists prospectively review any ED orders before administration of the first dose.

Review of wrong-dose/overdosage medication errors reported to the Authority found that in 150 reports (33.2%), excessive doses were ordered by prescribers but caught and corrected by pharmacists. Such events are often referred to as “pharmacy interventions.”

Cases in which pharmacists actively “caught” erroneously dosed orders include the following:

A physician ordered a dose of 500 mg acetazolamide IV. The patient was on 500 mg PO [per os] acetazolamide once daily at home. The clinical pharmacist recommended that the dose be separated and given every six hours because the IV formulation was to be administered.

The physician was informed and they changed the order to 125 mg every six hours.

A prescriber ordered a heparin infusion to run at 400 units/mL, based on a dose at 970 units/kg/hr. The dose is high. The prescriber was contacted and the dose was changed to 18 units/kg/hr.

[R] [There was a] good catch by pharmacist during the processing of an order and prior to administration of the medication. A physician ordered insulin aspart 100 units three times a day with meals with a one-time dose of 100 units. When called to verify correctness of order, the physician said that he “saw the order on the . . . medication record.” He was asked to verify the dose with the patient. When he called back, it was discovered that the patient takes 15 units TID with meals.

The predominant classes of medications mentioned in wrong-dose/overdosage errors included antibiotics (30%, n = 45), steroids (21.3%, n = 32), and NSAIDs (9.3%, n = 14). The predominant medications mentioned were dexamethasone (11.3%, n = 17), prednisolone (6%, n = 9), ketorolac (4.7%, n = 7), and acetazolamide (4.7%, n = 7).

RISK REDUCTION STRATEGIES FOR THE ED

Healthcare facilities can strive to identify systems-based causes of the medication errors that take place in the ED and implement effective risk reduction strategies to prevent harm to patients. Although most of the reports submitted to the Authority involving the ED did not explicitly reveal all of the causes and contributing factors linked to drug omissions and wrong-dose/overdosage events, healthcare facilities may consider the strategies described below, which are based on a review of events reported to the Authority, observations from the Institute for Safe Medication Practices, and recommendations in the literature.

Incorporation of Pharmacists into the ED

Healthcare facilities may consider the feasibility of increasing the involvement of
pharmacy departments in the ED’s medication-use process. This may include involving a pharmacist for important periods of time in the ED and including him or her in meetings involving medication use.

A study to determine the frequency of medication errors in one facility’s ED before and after an ED pharmacist was assigned to check medication orders found that the rate of errors decreased significantly (66.6%) when pharmacists prospectively reviewed the orders. In addition, other healthcare facilities that have used pharmacists in their EDs have shown improvements in many aspects of medication use, such as reducing medication order turnaround time, making medications more readily available, and improving compliance with clinical indicators. In such facilities, pharmacists have assisted ED staff with drug selection, drug administration, and patient monitoring, as well as with emergency and trauma-related codes. Pharmacists have expanded their role in the ED to assist with culture and susceptibility report follow-up, antibiotic selection, review of patients’ known medication history, analysis of unidentified tablets, and assisting in the medication-reconciliation process.

Multidisciplinary Teamwork
Healthcare facilities may consider instituting a multidisciplinary approach to patient care in the ED. A study to identify and decrease adverse medication events implemented a multidisciplinary practice consisting of a pediatric hospitalist, a pediatric care coordinator, a pediatric nurse, a pharmacist, and the trauma service to manage pediatric trauma patients from admission until discharge. The team mandated collective decision making for medication dosing, medication administration, and weight documentation, and it implemented a medication error reporting system. This effort resulted in a significant reduction in the number of medication prescribing and administration errors as well as a significant improvement in weight documentation.

Constraints
Based on the large number and variety of antibiotics mentioned in events reported to the Authority, healthcare facilities may consider limiting the number and variety of medications in the ED as well as limiting the number of available concentrations of a medication. Medication stock can be reviewed frequently to ensure that it includes only those drugs, concentrations, and quantities considered safe and necessary for emergency use.

Redundancies
Most organizations may not have active pharmacy involvement in the medication-use process in their ED. Redundancies such as the following can be included throughout the medication-use process in the ED:

- Require independent double checks for high-alert medications, particularly those removed on a “stat” basis or those used outside of a pharmacy-profiled situation.
- When communicating an order verbally or by telephone, expect a “read-back” for the order. During an emergency, expect a “repeat-back” confirmation from the listener.
- Many EDs use computerized prescriber order-entry systems to enter medication orders. If pharmacists are not involved in the review of the medication orders, healthcare facilities cannot rely on this technology to effectively detect potentially harmful medication errors and should consider testing the system’s ability to detect unsafe orders.

Drug Information
To minimize the risk of error, up-to-date drug information must be readily accessible to healthcare providers, including text references, protocols, order sets, computerized drug information systems, medication administration records, and patient profiles. Strategies to address problems with drug information include the following:

- Ensure the availability of equipment in the ED to easily obtain an accurate patient weight, including stretchers with built-in scales or floor scales that can weigh the patient and the stretcher, chair scales, and portable standing scales.
- Create a departmental expectation that obtaining actual weight is a mandatory assessment for adult patients just as it is for pediatric patients, unless life-threatening circumstances do not allow it.
- Standardize measurement systems to kilograms throughout the institution. Kilograms should be the standard units for weight on prescriptions, medical records, and staff communications.
- Consider the use of a “hard stop” in the department’s computerized prescriber order-entry system to alert staff if the weight parameter of kilograms is empty when a weight-based medication is ordered. Avoid prescribing weight-based medications unless an accurate patient weight is available.

Patient Weight
A patient’s weight is an important information often used to calculate the appropriate medication dose. When medication errors arise because a patient’s weight is unknown or inaccurately documented, the dose of a prescribed medication could be significantly different from what is appropriate. Strategies to address these problems include the following:

- Ensure that nurses have ready access to standardized emergency drug preparation sheets that indicate the safe preparation of the medication,
the correct rate of administration or infusion,
the correct method of titration,
whether an infusion device is required, and
the maximum dose range limits.

— Adopt a standardized approach for providing weight-based, pediatric emergency drug references in all appropriate areas of the ED. This approach may also be applicable to other patients receiving weight-based medications.

— Provide staff with ready access to online drug information resources that are continually updated. Make it easy for staff to access and use the online resources by providing an icon on the desktop of all computers, and place a computer at the ADC. Provide the same drug resources and references in the ED as in the pharmacy.

CONCLUSION

One of the most common care areas where medication errors take place in Pennsylvania healthcare facilities is the ED. The predominant types of medication errors include wrong-dose/overdosage and drug omission errors. Increasing the involvement of the pharmacy department, as well as instituting a multidisciplinary approach to patient care in the ED, may be an effective strategy to address problems with the prescribing of wrong doses of medications.

NOTES


SELF-ASSESSMENT QUESTIONS

The following questions about this article may be useful for internal education and assessment. You may use the following examples or come up with your own.

Upon admission, the patient’s weight was estimated to be 100 kg. Based on that, a bolus of 8,000 units of heparin was administered along with an IV [intravenous] infusion of 20 units/kg/hr. The patient’s first heparin level came back at midnight at more than 1.10 and the patient was experiencing gross hematuria. Heparin was discontinued at that point to be reevaluated. It was then discovered that the actual weight of the patient was 90 kg, which represents a 10 kg (10%) difference in weight.

1. Review this case and select the best strategy to prevent similar medication errors in the ED.
   a. Ensure the availability of equipment in the ED to easily obtain an accurate patient weight.
   b. Create an expectation that obtaining actual weight is a mandatory assessment for adult patients, unless life-threatening circumstances do not allow it.
   c. Adopt a standardized approach for providing weight-based, emergency drug references in all appropriate areas of the ED.
   d. Check the patient’s recorded weight against other sources, such as a family member or medical records.

2. The predominant classes of medications mentioned in events in the ED include all of the following EXCEPT:
   a. Opioids
   b. Antiemetics
   c. Anticoagulants/antithrombotics
   d. Antibiotics
   e. Nonsteroidal anti-inflammatory drugs

3. The most common types of medication errors that took place in the ED, as reported to the Authority, include all of the following EXCEPT:
   a. Wrong patient
   b. Drug omission
   c. Wrong dose/overdosage
   d. Wrong drug
   e. Wrong dose/underdosage

4. Analysis of wrong-dose/overdosage events that occurred in the ED, as reported to the Authority, revealed problems with breakdowns in patient information in all of the following areas EXCEPT:
   a. Weight
   b. Age
   c. Knowledge of existing medication profiles
   d. The medication reconciliation process
   e. Laboratory values

5. All of the following statements in regard to the pharmacy’s role in the ED are true EXCEPT:
   a. The pharmacist is often not a part of the medication-use process in the ED.
   b. Historically, the role of the pharmacy in the ED has been limited to stocking automated dispensing cabinets, preparing emergent IV solutions, and retrospectively reviewing medication orders.
   c. Review of drug omission errors reported to the Authority found that in one-third of the reports, excessive doses were ordered by prescribers but caught and corrected by pharmacists.
   d. Studies have shown that the rate of medication errors in the ED decreased significantly when pharmacists prospectively reviewed ED medication orders.
   e. Facilities that have used pharmacists in their EDs have shown improvements in medication order turnaround time, medication availability, and compliance with clinical indicators.
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THE PENNSYLVANIA PATIENT SAFETY AUTHORITY AND ITS CONTRACTORS

The Pennsylvania Patient Safety Authority is an independent state agency created by Act 13 of 2002, the Medical Care Availability and Reduction of Error (“Mcare”) Act. Consistent with Act 13, ECRI Institute, as contractor for the Authority, is issuing this publication to advise medical facilities of immediate changes that can be instituted to reduce Serious Events and Incidents. For more information about the Pennsylvania Patient Safety Authority, see the Authority’s website at http://www.patientsafetyauthority.org.

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The Institute for Safe Medication Practices (ISMP) is an independent, nonprofit organization dedicated solely to medication error prevention and safe medication use. ISMP provides recommendations for the safe use of medications to the healthcare community including healthcare professionals, government agencies, accrediting organizations, and consumers. ISMP’s efforts are built on a nonpunitive approach and systems-based solutions.