

# Emergency Medicine Specialty Reports

Supplement S08178

March 2008

## Introduction

Americans use many medications for countless medical conditions, spending about \$100 billion annually.<sup>1</sup> Unfortunately, partly because we use so many medications, medication error has become an important medical topic in the 21st century. The Institute of Medicine's 2006 Report on "Preventing Medication Error" noted that medication errors are the most common type of medical error, harming at least 1.5 million people every year.

The extra medical costs of treating medication-related injuries occurring in hospitals alone is \$3.5 billion per year, and this estimate does not include lost wages or additional health costs. When all types of errors are considered, an average hospital patient can be subjected to more than one medication error each day.<sup>2</sup> Up to 98,000 people die yearly from in-hospital medical errors—more than from motor vehicle accidents, breast cancer, or AIDS.

Indeed, more people die annually from medication errors than from workplace injuries. Considering the morbidity, mortality, and costs, medical error is one of the most urgent, widespread public health problems.<sup>3</sup> Because of increased attention in the media, public interest in this issue has grown. The goal of this article is to introduce some of the basic considerations of medication errors: definitions, frequency, consequences, and possible solutions.

## Organizations Involved in Medication Error

Many organizations are involved in the evaluation and management of medication errors. (*See Insert.*) The Institute of Medicine (IOM) has become one of the most prominent because of its reports as a part of its "Quality Chasm Series." Its 2000 report, "To Err is Human: Building a Safer Health System," stimulated national awareness and discussion on the topic of medical error. Much of this article is based on its 2006 report on "Preventing Medication Errors."

## Key Definitions

The terminology pertaining to medication-related events is vast and confusing. The original terms were derived by regulatory agencies that had a focus on drug effects. Today there is increased attention on quality improvement, and with this change came new vocabulary. Unfortunately, there is disagreement among authors as to some of the definitions. The IOM supports the following definitions in its publications.

**Error** is the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim. It may be an act of commission or of omission.<sup>2</sup>

**Medication error** is an error occurring during the process of using medications. Examples include wrong dosage prescribed, wrong dosage administered for prescribed medication, or failure to give (by provider) or take (by the patient) a medication. By

## Medication Error Prevention

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this definition, all medication errors are preventable.<sup>4</sup> The National Coordinating Council for Medication Error Reporting and Prevention defines a medication error as “any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in control of the health care professional, patient or consumer.”<sup>5</sup>

**Adverse drug event (ADE)** is any preventable or non-preventable injury due to a medication adverse event. An ADE due to a medication error is “preventable.”

**Adverse drug reaction (ADR)** is an ADE that is non-preventable.<sup>6</sup> It is “any noxious, unintended, and undesirable effect of the drug which occurs at doses used in humans for prophylaxis, diagnosis or therapy.”<sup>7</sup> It results from an intrinsic property of the drug itself while using the medication in the recommended manner.<sup>8</sup> This definition excludes therapeutic failures, overdose, non-compliance, and drug abuse.

## Frequency of Errors

In any week, 80% of American adults will use prescription medications, over-the-counter drugs, or dietary supplements. The National Hospital Ambulatory Medical Care Survey, which collected data on care provided by hospital emergency departments (EDs), estimated 110.2 million visits for 2002. Medications were administered or prescribed during 76% of the ED visits, and approximately 2.3 medications were prescribed or dispensed per visit, resulting in 192.6 million annual ED medication orders.<sup>9</sup> Different studies indicate that drug-related injuries occur in 400,000 in-patients and 800,000 long-term care patients annually. Another 530,000 occur just among Medicare recipients in outpatient clinics.<sup>10</sup> At least 1.5 million preventable ADEs occur yearly in the United States.<sup>10</sup> These data are very conservative estimates.<sup>3</sup>

Medication use likely will increase due to an aging popula-

tion, the continued development of new prescription medications, the transition from prescriptions to over-the-counter availability, and the increasing use of medications for chemoprevention.<sup>11</sup> Although most health problems associated with the use of pharmaceuticals are relatively minor, serious ADEs do result in hospitalizations, disability, and deaths. Because exposure to prescription drugs is so high, even a very low ADE rate leads to many serious injuries and deaths.<sup>1,12</sup>

## Costs of Medication Errors

Data on costs are lacking. An estimate of 400,000 in-hospital ADEs will result in \$3.5 billion in extra cost in 2006 dollars. For ambulatory Medicare patients, the estimated cost in 2000 was \$887 million. These cost estimates are likely low because our estimates of the frequency of ADEs are low. In addition, these cost estimates do not include other potential error-related costs, including the use of medications without a good indication, the failure to receive medications that were indicated, lost patient earnings, and compensation for pain and suffering.<sup>13</sup>

## Errors in the Emergency Department (ED)

Many ED environment factors exacerbate the frequency of medication errors. Emergency department patients are generally strangers. Emergency medicine physicians rarely have access to medical records, medication lists, or allergy or past medical histories. Patients are often unable to detail their medical conditions or medications. Multiple distractions are present, and pharmacists are often not involved in medication dispensation.

The medications used in the ED add to the potential for error and the risks to the patients. Critically ill patients are more likely to receive medications that have increased risks associated with their use and to have increased chances for drug interactions and complications of renal and hepatic derangements. The increased use of intravenous medications has its own inherent risks. Error potential is also increased because medication administration is often “time pressured.”<sup>14,15</sup>

## Medication Error Taxonomy and Types

The medication process consists of four to six stages (depending on the author): procuring the medication, prescribing, transcribing, dispensing, administration, and monitoring.<sup>5,14</sup> Medication errors often are described based upon the stage of the medication process during which they occur. Multiple errors may occur during any of the stages. The complexity of the process of getting medication to a particular patient, with multiple stages and multiple steps within each stage, creates a vast opportunity for errors. Most serious in-hospital medication errors (39-71%) occur in the prescribing stage.<sup>14,16</sup> The most common problem facing physicians in this stage is an inadequate knowledge base of all the medications available, particularly now that the number of new medications is rising rapidly. The second most common problem during the prescribing stage is lack of familiarity with the patients, which is especially problematic for emergency physicians.<sup>14</sup>

The American Hospital Association lists some common types of medication errors. Incomplete patient information includes not

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**GST Registration No.:** R128870672

Periodical postage paid at Atlanta, GA. **POSTMASTER:** Send address changes to **Emergency Medicine Specialty Reports**, P.O. Box 740059, Atlanta, GA 30374.

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knowing about patients' allergies, other medications they are taking, previous diagnoses, or laboratory results. Incomplete drug information includes up-to-date warnings not being available. Miscommunication relative to medication orders includes poor handwriting, confusion between drugs with similar names, misuses of zeroes and decimal points, confusion of metric and other dosing units, inappropriate abbreviations, and labeling errors during packaging and repackaging. Multiple environmental factors, including lighting, heat, noise, and interruptions, affect decision making.<sup>17</sup>

The majority of medication errors involve incorrect dose/quantity followed by omission errors. Other less frequently reported types of errors include: wrong drug, wrong administration time, extra dose, wrong patient, mislabeling, and wrong administration technique. During 10 months in 2004-2005, the USP received 2022 reports of medication reconciliation errors. Of those reports, 66% occurred during the patient's transition or transfer to another level/location of care, 22% occurred during the patient's admission to the facility, and 12% occurred at the time of discharge.<sup>18</sup>

### Detection of Medication Errors

Medication error rates vary considerably among studies, depending primarily on the study techniques used. The most common technique is the use of "self-reported" data. Other sources include chart reviews and direct observation.

Self-reported data include hospital-based "Incident Reports," the FDA's MedWatch program, and the USP's MEDMARX and MERP programs. While these are among the most available data sources on medication error, they identify only 2-5% of reportable ADEs. Self-reporting has many limitations, including personnel who are already overburdened with their standard tasks. Self-reporting is also dependent on a positive cultural norm that encourages reporting and that does not focus on individual blame. Unfortunately, the current tort system is fully focused on blame, and there continues to be concern about speaking up about possible errors.<sup>19,20</sup> The Agency for Healthcare Research and Quality established the Hospital Survey on Patient Safety Culture Comparative Database through a survey of 382 hospitals and 108,621 hospital staff in 2006. Only 43% of individuals felt that their mistakes and event reports were not held against them and that 65% "worry that mistakes they make are kept in their personnel file." No safety events were reported in the hospitals of 53% of the respondents over the previous 12 months, reflecting a significant underreporting of events.<sup>21</sup>

Chart reviews are used to detect errors in many of the medication stages. They require more time to perform than obtaining self-reported data and thus are more expensive. Direct observation is possibly the most sensitive method of error detection. It is not affected by many of the limitations of the other techniques. However, it is very expensive because it requires a well-trained observer. One study compared a chart review with direct observation of the same 2557 doses of medication. The chart review revealed 24 administration errors while direct observation noted 456 errors.<sup>17</sup> Another study compared a chart review with self-reporting of medication errors during 1448 patient days at a psychiatric hospital. The chart

review and self-reporting revealed 2194 errors and nine errors, respectively.<sup>17</sup>

### Error-Prone Abbreviations

Many medication mistakes result from abbreviations in medical records that are misinterpreted. These abbreviations are used in many forms of communication, including written orders, computer order screens, computer generated labels, labels for drug storage bins, and medication administration records. The Joint Commission established a National Patient Safety Goal that certain abbreviations should not be used, highlighted by the "do not use" list. (*See Insert.*)<sup>18</sup>

### High-Alert, Look-Alike Medications, and More

Certain medications are associated with more errors. Some medications have a narrow therapeutic window: a limited dosing range between being therapeutic and toxic. Their pharmacologic properties make them difficult to use even when administered in generally recommended doses. These agents have been termed "high alert" medications by the Institute for Safe Medication Practices (ISMP).<sup>22</sup> Other medications have increased errors associated with them because they look like or sound like (look alike/sound alike or LASA) other medications and are easily confused.

While the number of errors associated with the high-alert medications is likely not higher than with other medications, the clinical significance when they do occur can be devastating. The ISMP lists these medications both by classes/categories and by specific medication name. The ISMP lists 19 classes/categories of high-alert medications; EDs commonly use medicines within 12 of them. These classes include adrenergic agonists and antagonists, intravenous anesthetic agents, concentrated dextrose, glycoprotein IIb/IIIa inhibitors, inotropic medications, sedating agents, neuromuscular blocking agents, intravenous opioids, radiocontrast agents, and thrombolytics. Twelve of the 14 specific medications listed by ISMP are used in the ED: amiodarone, heparins of all types, insulin, lidocaine, magnesium, nesiritide, nitroprusside, potassium chloride and phosphate, hypertonic sodium chloride, and warfarin.<sup>22</sup> It is concerning that in the MEDMARX reported collection of medication errors, the high-alert medications were among those commonly cited: insulin, morphine, heparin, potassium chloride, and warfarin.<sup>23</sup>

Some recent data suggest that insulin, opioids, and antibiotics are the most error-prone medications.<sup>24</sup> All of these are used frequently in the ED. Different insulins can have varied durations of action but similar names (e.g., Humalog and Humulin). Many of the opioids have names that are easily confused: morphine vs. hydromorphone; hydrocodone vs. hydromorphone; hydrocodone vs. oxycodone vs. codeine. Many of these agents have similar packaging, enabling errors. Oral morphine solutions exist in different concentrations and it is easy to mistake "ml" with "mg" and overdose the patient.<sup>24</sup> Errors with antibiotic oral solutions occur easily because they exist in various concentrations and are dosed using various units including "ml," "tsp," and "tbl." Confusing these units can cause 5- to 15-fold overdosing or under

dosing. Oral antibiotics often require reconstitution, which includes another opportunity for error by using the wrong liquid, such as alcohol instead of distilled water.<sup>24</sup>

The list of LASA agents continues to grow. The ISMP's LASA list contains 178 pairs that have been reported to them.<sup>223</sup> Many of the LASA medications are prescribed within an ED. The most commonly confused brand names are Celebrex (celecoxib), Cerebyx (fosphenytoin), and Celexa (citalopram).

### Extremes of Age

Patients who are not in charge of their medications are especially vulnerable to error. Many studies identify pediatric and elderly patients as having increased risks of ADEs.

**Pediatrics.** Many factors can affect ADRs in children. Through childhood there is steady change in pharmacokinetics and pharmacodynamics, organ development, physical growth, and the development of puberty.<sup>25</sup> Children are more sensitive to particular toxic effects including gray baby syndrome caused by impaired metabolism of chloramphenicol, Reye's syndrome from aspirin, hepatotoxicity from valproic acid, metabolic acidosis caused by propofol, and the skin manifestations associated with lamotrigine.<sup>25</sup> The median age of children to have an ADR is 5 years and most reports involve infants in the first year of life.<sup>25</sup>

Environmental factors affect pediatric medication errors. Young children and high-acuity patients are at an increased risk of ADEs in both the prehospital and ED settings.<sup>26</sup> In a chart review of medication and intravenous fluid use, most errors occurred on the evening and night shifts. The most common errors were incorrect dose of medication (35%) or wrong medication given (30%). Common causes for medication errors in the pediatric ED include incorrect recording of the patient's weight resulting in incorrect medication dosing, and failure to note drug allergies.<sup>27</sup> Such errors lead to prolonged hospitalization, unnecessary diagnostic tests and treatments, and death.<sup>28</sup>

Of the medication errors in pediatric patients, some are categorized as "potential to cause harm" and most as "causing no harm."<sup>29</sup> In a review of medication orders, one study found that 5.7% were associated with medication errors, 1.1% were potential ADEs, and 0.24% were ADEs. Of the identified ADEs, 19% were preventable.<sup>30</sup> Of note, preventable ADEs were similar to those in adult studies; however, the potential ADE rate was three times higher in children. Potential ADEs occurred particularly often in newborns in the neonatal intensive care unit. Most potential ADEs occurred at the stage of drug ordering (79%) and involved incorrect dosing (34%).<sup>30</sup> The group of drugs most likely to be associated with a suspected ADR associated with death was anticonvulsants.

**Elderly.** The aging population, availability of many new drugs, and changes in medication consumption patterns threaten to increase medication errors and drug interactions.<sup>31</sup> Because the geriatric population uses many medications, this group will likely be disproportionately affected by errors. A national survey of non-institutionalized adults aged 65 years or older found that more than 90% used at least one medication, more than 40% used five or more, and 12% used 10 or more medications per week.<sup>32</sup> In a

study following 27,617 Medicare Plus Choice Plan patients, 2268 had possible drug-related incidents. The overall rate of ADEs was 50 per 1000 person-years and 14 preventable ADEs per 1000 person-years. Sixteen events resulted in permanent disability or death. Permanent disability included one stroke, two intracranial bleeding events, one hemorrhagic injury to the eye, and one drug-induced pulmonary injury. The six deaths in this study resulted from bleeding, anaphylaxis, and complications of antibiotic-associated diarrhea.<sup>32</sup> The 1523 ADEs were associated with many drug classes: cardiovascular drugs in 26%; antibiotics/anti-infectives in 14.7%, hypoglycemics in 6.8%, steroids in 5.3%, opioids in 4.9%, antidepressants in 3.2%, sedative/hypnotics in 0.6%, and antipsychotics in 0.5%.<sup>32</sup> In a study of long-term care facility patients, it was noted that those using medications in several drug categories were at increased risk of a preventable ADEs.<sup>33</sup>

**Elderly and Warfarin.** Warfarin is one of the most "dual-edged" swords that physicians use. It is the only oral anticoagulant currently available, but using it appropriately and safely is very difficult. It has a narrow therapeutic window, extensive interactions with other medications and foods via the P450 enzyme system, and a need for close monitoring. The literature is replete with reports of ADEs associated with warfarin. The elderly are particularly prone to warfarin-related events for many reasons, including the increased use of multiple medications. For example, a 12-month study on the safety of warfarin in the nursing home setting identified 720 warfarin-related ADEs and 253 potential warfarin-related ADEs. Overall, 29% of the ADEs were preventable. Most errors resulted from the prescribing and monitoring stages of management.<sup>34</sup> Monitoring stage errors generally represented inadequate laboratory monitoring of drug therapies or delayed/failed response to signs or symptoms or laboratory evidence of drug toxicity.<sup>32</sup>

The Joint Commission has recognized the dangers of warfarin and other anticoagulants. The 2008 National Patient Safety Goals (NPSG) and Requirements include a new goal, 3E, "Reduce the likelihood of patient harm associated with the use of anticoagulation therapy."<sup>18</sup> All anticoagulants are high-alert medications that commonly lead to ADEs due to their complex dosing and monitoring and poor patient compliance with outpatient therapy. In addition to warfarin, these also include unfractionated and low molecular weight heparins and direct thrombin inhibitors.

The use of standardized practices that include patient involvement with outpatient care can reduce the risk of ADEs. Protocols for initiating and maintaining anticoagulation therapy should be initiated. Baseline laboratory tests should be obtained prior to therapy initiation. Continual education of staff, pharmacists, and caregivers should occur at least annually. In addition, patients should be educated by the caregiver about the benefits of therapy, potential side effects, importance of follow-up monitoring, compliance issues, dietary restrictions, potential for drug interactions, and safety precautions. Identification of medication errors involving anticoagulants should be reviewed continually.<sup>35</sup>

### Solutions

The number of potential solutions to decrease medication

errors is large, reflecting the complexity of the total medication production and delivery process. These have been well described in multiple sources.<sup>2,5,17</sup> Virtually none of the recommendations have supporting research. Of course, increased research on this topic is one of the first recommendations. It is unlikely that industry will fund much of this future research, thus, the government will have to contribute significantly if this work is to be done. Potential areas of research include obtaining data on the true incidence and severity of medication error, costs, and reporting systems. Paradoxically, despite many medication errors affecting the elderly who have co-morbidities, most clinical trials of new medications exclude these patients.

A detailed discussion of possible solutions is beyond the scope of this paper. Some of the options include improved applications of information technology, improved communications between all parties, an increased focus on systems vs. on individual actions, increased knowledge by providers about their patients and about the medications, an improvement in environmental factors that affect human decision making, a change in medication design and marketing, an improvement in the process of medication administration, enhanced monitoring for adverse drug events, an increased organization emphasis on a culture of safety, increased governmental support of standardizations of most aspects of the medication process, and improved use of pharmacists throughout the medication administration process. A few of these options will be addressed in more detail.

Improved communications between individuals and better communication of information are likely the most important factors that will decrease medication errors. Erratic and inconsistent information on medications is a problem for providers and patients alike. Some forms of communication should be relatively simple. For example, the IOM report recommended that agencies should work together to standardize and improve the medication information leaflets provided by pharmacies, improve drug information availability over the Internet, and develop a 24-hour national telephone helpline that offers consumers easy access to drug information.<sup>2</sup>

### **Information Technology**

Information technology (IT) will contribute significantly to the reduction of medication errors. Patient information may be more available via multiple technologies including “swipable” smart cards/healthcare passports from which information can be read or to which it can be added, electronic medical records (EMR) that can be accessed, or radiofrequency identification (RFID) chips that are implanted subcutaneously. Other IT possibilities include computerized physician order entry with evidence-based clinical decision making support, electronic prescriptions, bar-code technology on all medications, and standardized medication reference systems. Medication administration records could be standardized and become a part of a patient’s EMR. Standardized web-based resources could be beneficial. These might include medication reference systems for both providers and patients and updated safety alerts.

The evaluation of computerized physician order entry (CPOE) has revealed mixed results. One series looked at the frequency of

medication errors and ADEs before and after the implementation of CPOE in pediatric inpatients. With CPOE, there was a significant decrease in the rate of medication errors, but not ADEs. An average of 490 patient days was required to see the benefit of one less medication error.<sup>36</sup> Another study indicated that CPOE decreased the rate of serious medication errors by more than half. This decrease was larger for potential ADEs than for actual ADEs. When CPOE alone was compared with CPOE combined with a team intervention, the team intervention provided no additional benefit.<sup>12</sup> However, another series described the frequency and types of inpatient ADEs that occurred following the adoption of multiple computerized medication ordering and administration systems, including CPOE. High rates of ADEs continued to occur after the systems were implemented. It was felt that the lack of clinical decision support for drug selection, dosing, and monitoring may have impacted the results.<sup>37</sup>

Another potential IT solution is the use of bar-coded medications. This involves placing a bar code on the packaging of medications, enabling tracking through the use of optical scanners. The medication bar code encodes the National Drug Code, which includes the drug company labeling, the name and dose of the drug, and the type of packaging. In a 2005 national survey, the American Society of Health System Pharmacists reported that 9% of hospitals used bar code medication administration. Some benefit has been demonstrated through their use. One series reflected that 73 administration-related errors were intercepted through electronic bar-code scanning for every 100,000 doses charted.<sup>38</sup> While the bar code can decrease medication errors at the administration phase, it can have errors associated with its use. These errors include mislabeled medications, medications without bar codes, and medications with bar codes that will not scan.<sup>39</sup>

Smart cards, also called health passports, are another form of IT that have been used recently to reduce medication error and improve communication. Smart cards can be used as a secure portable EMR with medical data and insurance information. The different types of smart cards incorporate microfilm, bar-codes, magnetic-strips, or integrated circuits.<sup>40</sup> Potential problems include storage capacity, backup and data consistency, access authorization, ownership, and compatibility.<sup>40</sup>

The use of IT can assist physicians with keeping up with the burgeoning number of medications available for prescription. The most immediate step is to ensure that EDs have access to medication-related reference materials.<sup>14</sup> Electronic references are generally the most expedient and can be the most up-to-date. The reference system should be made as user-friendly as possible, requiring the fewest key strokes or mouse clicks. However, the best use of IT to support physicians with the impossible tasks of remembering all there is to know about medications is the use of clinical decision support mechanisms. For example, benefit may result from the use of software that recognizes potential drug interactions that is associated with computerized physician order entry and with computer-based prescriptions done at the time of discharge.

Transcription errors, ones that occur when communications between the prescriber and the person dispensing or administering the medication, can be decreased with IT.

Computerized physician order entry can ensure a standardized vocabulary, improving communication. Inclusion of a drug's indication on all ER orders or discharge prescriptions decreases the likelihood of prescribing a sound-alike medication. Computerized order entry also decreases the use of abbreviations and confusing orders such as trailing zeros.<sup>14</sup>

### **Pharmacist Intervention**

While many types of health care providers can reduce medication errors, pharmacists are positioned to have a significant impact. They are involved in the care of both hospitalized and ambulatory patients and in most stages of the medication administration process. For ambulatory patients, pharmacists are the last providers to interact with patients before medications are taken. The role for pharmacists is evolving, especially for patients in the ED or the intensive care unit. Pharmacists have decreased medication costs by interacting directly with health care providers. In a four-month prospective study in one ED, 2150 pharmacist interventions were made in the care of 1042 patients. Interventions were assessed according to potential cost avoidance and probability of harm. The intervention could have potentially decreased costs by \$1 million during this study period.<sup>9</sup> By performing medication reviews and providing counseling to inpatients who were about to be discharged and doing telephone follow-ups with the discharged patients, pharmacists decreased preventable ADEs that occurred within 30-days of discharge. Pharmacists, by assisting in the transition of patients from the hospital to long-term care facilities, have decreased patient pain and hospital usage.<sup>41</sup>

### **Look-Alike/Sound-Alike (LASA) Medications**

Recent observational studies of medication errors in community pharmacies suggest that "wrong drug" errors may occur up to 3.9 million times per year in the United States.<sup>42</sup> One of the new Joint Commission National Patient Safety Goals for 2005 required organizations to identify and annually review a list of look-alike/sound-alike drugs and to implement safety strategies to prevent medication errors involving these drug combinations. Strategies used by institutions have varied. Some post warnings and alerts both electronically and in areas where drugs are used. Others include the indication for the medication on the prescription. Other strategies include storing drugs with easily confused names in different locations, improving lighting to decrease visual fatigue, using computers to prescribe, listing both the brand and generic names, providing magnifiers, removing one of the confusing drugs from the system, and insisting on double-checking for products thought to be vulnerable to confusion. Another approach is changing the appearance of look-alike product names on computer screens, pharmacy and nursing unit shelf labels and bins, and pharmacy product labels. The names are highlighted by use of a bold face, a new color, or tall man letters where parts of the names are different (e.g., hydrOXYzine, hydrALAzine).<sup>43,44</sup>

### **Medication Reconciliation**

Medication reconciliation was established as one of the 2005

National Patient Safety Goals of the Joint Commission. This is the process of comparing any new medication orders or prescriptions to all of the medications that the patient has been taking. The purpose is to avoid errors such as omissions, duplications, dosing mistakes, or drug interactions. The Joint Commission stresses that this should be done at every transition of care—essentially most health care visits.<sup>18</sup> Some of the initial studies assessing benefit have been favorable. It has reduced discrepancies in drug frequency and dose and in therapeutic duplication at the time of discharge.<sup>45</sup> In the ED, pharmacist-conducted medication reconciliation increased compliance to the institution's medication reconciliation policy for admitted patients.<sup>46</sup> Pharmacist medication reconciliation and communication with the physician reduced discrepancy-related ADEs in patients transferred between the hospital and nursing home.<sup>47</sup>

### **Human Factor and Error**

Human-related factors that result in medication errors include limited memory, environmental factors, and fatigue. Much unfounded reliance upon memory has been placed upon providers. This challenge only worsens with time as more medications reach the market and new safety alerts and package insertion safety changes occur. Human factors that correlate with improved safety of using medications are simplicity, standardization, differentiation, lack of duplication, and unambiguous communication.<sup>48</sup>

Multiple environmental factors affect our ability to focus on clear decision making and execution. These include fatigue, noise, general comfort, and distractions—all of which are constantly present in the busy ED environment.

Fatigue may have the most serious impact of all the human factors. Sleep deprivation is well associated with adverse events. In an attempt to improve on human error, the Accreditation Council for Graduate Medical Education mandated an 80-hour maximum work week rule for all residency programs in July 2003. Some studies have assessed if this change would affect safety outcomes including mortality, adverse events, and medication errors. While it seems logical that the change would benefit patient care, study results have been mixed.<sup>49</sup> One study assessed interns in critical care units, comparing a traditional every third night call schedule associated with shifts longer than 24 hours with an intervention schedule with a schedule with decreased hours and all shifts less than 24-hours. The rate of serious errors was 22% higher during the traditional schedule than during the intervention schedule (193.2 vs. 158.4 per 1000 patient-days,  $P < 0.001$ ).<sup>50</sup> Conversely, in a comparison of ADEs before and after limiting medical residents to a maximum of 80 hours per week, no significant differences between study periods was found. Measured variables included the number of confirmed ADEs (194 before, 172 after), number of ADEs per 1000 patient days (1.3 before, 1.1 after), and number of preventable ADEs (21 before, 22 after). Hospital-wide ADEs remained constant despite the limiting of resident physician weekly work hours.<sup>51</sup>

### **Patient-Provider Relationship**

An important mechanism to enhance health care is to foster a patient and health care provider partnership. The 2006 IOM

report on medication error stressed that one of the most important actions is continued movement away from the paternalistic, physician-centered approach to care.<sup>2</sup> The report clearly supports that both providers and patients need to increase their communication with each other. Physician communication and education about new medicines is critical to proper use and patient adherence. In one series, physicians scored a mean of 3.1 of a possible 5 expected elements of communication when initiating new prescriptions. Physicians counseled more about psychiatric medications than about pulmonary and cardiovascular agents, averaging 3.7, 3.5, and 3.4, respectively.<sup>52</sup>

Patients should understand their medications, maintain their own medication records, and take responsibility for monitoring them. Patients need to tell their providers how new medications have affected them, and the physicians need to listen.

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## Physician CME Questions

1. An adverse drug reaction (ADR) is defined as:
  - A. any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in control of the healthcare professional, patient, or consumer.
  - B. an error occurring during the process of using medications.
  - C. any preventable or non-preventable injury due to a medication

adverse event.

- D. any noxious, unintended, or undesirable effect of the drug that occurs at doses used in humans for prophylaxis, diagnosis, or therapy.
2. Which of the following is *not* an example of an error-prone abbreviation, symbol, or dose designation?
    - A. OD
    - B. SSRI
    - C. mcg
    - D. qhs
    - E. IU
  3. Which of the following medications is prone to medication errors in the ED?
    - A. Acetaminophen
    - B. Insulin
    - C. Epinephrine
    - D. IV contrast media
    - E. NSAIDs
  4. Which of the following abbreviations should *not* be used when prescribing or ordering medication?
    - A. 0.5 mg
    - B. 1 mg
    - C. MS 8 mg IV
    - D. 100,000 units
  5. Which of the following solutions may be helpful in reducing the number of medication errors experienced in the ED?
    - A. Smart cards or health passports
    - B. Bar-coded medication tracking
    - C. Computer physician order entry (CPOE)
    - D. Access to medication-related reference materials
    - E. All of the above

## CME Answer Key

1. D; 2. C; 3. B; 4. C; 5. E

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