

# Medication Errors: An Overview for Clinicians

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## Abstract

Medication error is an important cause of patient morbidity and mortality, yet it can be a confusing and underappreciated concept. This article provides a review for practicing physicians that focuses on medication error (1) terminology and definitions, (2) incidence, (3) risk factors, (4) avoidance strategies, and (5) disclosure and legal consequences. A medication error is any error that occurs at any point in the medication use process. It has been estimated by the Institute of Medicine that medication errors cause 1 of 131 outpatient and 1 of 854 inpatient deaths. Medication factors (eg, similar sounding names, low therapeutic index), patient factors (eg, poor renal or hepatic function, impaired cognition, polypharmacy), and health care professional factors (eg, use of abbreviations in prescriptions and other communications, cognitive biases) can precipitate medication errors. Consequences faced by physicians after medication errors can include loss of patient trust, civil actions, criminal charges, and medical board discipline. Methods to prevent medication errors from occurring (eg, use of information technology, better drug labeling, and medication reconciliation) have been used with varying success. When an error is discovered, patients expect disclosure that is timely, given in person, and accompanied with an apology and communication of efforts to prevent future errors. Learning more about medication errors may enhance health care professionals' ability to provide safe care to their patients.

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For editorial  
comment, see  
page 1027; for a  
related article,  
see page 1042

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Since the publication of the landmark Institute of Medicine (IOM) report *To Err is Human*,<sup>1</sup> there has been an enhanced focus on improving the safety of health care. Medication errors are one remediable portion of the safety continuum.

Medication use in the United States is highly prevalent. In a large national survey, 81% of people took a medication in the preceding week, and 50% took at least 1 prescription medication.<sup>2</sup> The complexity of modern pharmacotherapy lends itself to confusion by patients and errors by health care professionals. In a survey of hospitalized patients, only 27.9% could list their discharge medications, and even fewer could state the intended use of their medications.<sup>3</sup> Additionally, studies have reported hospital inpatient medication error rates of 4.8%<sup>4</sup> to 5.3%<sup>5</sup> and a relationship between medication errors and adverse events.<sup>5</sup> Importantly, both physicians and patients are reported to underestimate the number of deaths due to preventable errors of any type,<sup>6</sup> including deaths related to medications.

Medication errors are an important clinical issue. However, even at the most fundamental level, the definitions associated with these

errors can be confusing, and the impact on individuals and society can be underappreciated. This article provides an overview of medication errors for practicing physicians and focuses on medication error (1) terminology and definitions, (2) incidence, (3) risk factors, (4) avoidance strategies, and (5) disclosure and legal consequences.

## MEDICATION ERROR TERMS AND DEFINITIONS

Medication error terminology can be confusing because of overlapping definitions.<sup>7</sup> In health care, an *error* has been defined by the IOM as “the failure of a planned action to be completed as intended (error of execution) or the use of a wrong plan to achieve an aim (error of planning). An error may be an act of commission or an act of omission.”<sup>8</sup> A *medication error* has been defined by Bates et al<sup>5</sup> as “any error occurring in the medication use process” and focuses on problems with the delivery of a medication to a patient. Importantly, although some medication errors cause harm to the patient, most do not (eg, “near misses”).<sup>9</sup> In fact, one study of the frequency of medication errors discovered that

fewer than 1% of medication errors resulted in an adverse drug event.<sup>5</sup> Examples of medication errors could include giving a medication to the wrong patient, giving the wrong dose of a medication, not prescribing a medication that was indicated, entering an order for the wrong patient, or forgetting to give a medication that was due.

*Drug safety* (also known as *pharmacovigilance*) focuses on the safety and regulation of the drug itself. Drug safety is defined by the World Health Organization as the “science and activities relating to the detection, assessment, understanding, and prevention of adverse effects or any other medicine-related problem.”<sup>10</sup> An *adverse drug event* is “an adverse outcome that can be attributed, with some degree of probability, to an action of a drug.”<sup>7</sup> An adverse drug event may or may not be due to a medication error. For example, if a patient is given an antibiotic for the first time and a rash develops, it is an adverse drug event that was not caused by a medication error.<sup>5</sup> In contrast, if the patient is already known to be allergic to an antibiotic and is still given that drug, the rash that develops is an adverse drug event due to a medication error.<sup>5</sup>

*Adverse drug effect and reaction* can be defined as “an appreciably harmful or unpleasant reaction, resulting from an intervention related to the use of a medicinal product, which predicts hazard from future administration and warrants prevention or specific treatment, or alteration of the dosage regimen, or withdrawal of the product.”<sup>7,11</sup> More simply stated, adverse drug effects and reactions are nonpreventable adverse drug events.<sup>7,11</sup> However, with repeated administration of the drug, the adverse drug event becomes preventable. An *adverse drug effect* and *adverse drug reaction* are equivalent terms except that an effect is from the perspective of the drug and a reaction is from the perspective of the patient.<sup>7,11</sup> However, when assigning causality, clinical judgment must be used to determine if the effect or reaction is biologically plausible on the basis of what is known about the pharmacologic features of the medication.

Categories of medication errors have been developed in an attempt to standardize communication and reporting. These categories use different approaches to define the relationship between the types of errors and the types of harm.

The American Society of Health-System Pharmacists developed a system for categorizing medication errors based on prescribing, omission (ordered drug not administered), timing, use of an unauthorized drug (not authorized by a legitimate prescriber), improper dosing, wrong dosage form, wrong drug preparation, wrong administration technique, deteriorated drug (an expired medication), monitoring (failure to use laboratory data to monitor toxicity or effect), compliance, and other errors.<sup>12</sup> The American Society of Health-System Pharmacists has identified common causes leading to these errors, including drug product nomenclature, illegible handwriting, labeling errors, excessive workload (among physicians, nurses, or pharmacists), and medication availability (manufacturer shortages of medications).<sup>12</sup>

Medication errors may also be categorized as errors in planning and errors in executing that plan.<sup>13</sup> In practice, a comprehensive system that evaluates the harm, root cause, and psychological aspects of errors is beneficial to optimize communication and help prevent future errors.

When categorizing errors, it is also beneficial to account for the consequences of those errors, including patient harm. The National Coordinating Council for Medication Error Reporting and Prevention categorizes the relationship between error and harm as (1) no error (circumstances have the capacity to cause error), (2) error but no harm, (3) error and harm, and (4) error and patient death.<sup>14</sup> They further divide these 4 categories into a continuum that considers the need for monitoring, medical or surgical treatment, or life-sustaining therapy.<sup>14</sup>

#### INCIDENCE OF AND HARM FROM MEDICATION ERRORS

The IOM's *To Err is Human* estimated, on the basis of an older study, that medication errors cause 1 of 131 outpatient and 1 of 854 inpatient deaths.<sup>1</sup> The IOM later summarized the literature on medication error incidence rates in their 2007 report *Preventing Medication Errors*.<sup>9</sup> Individual studies have reported inpatient medication error rates of 4.8%<sup>4</sup> to 5.3%.<sup>5</sup> In another study, prescribing errors for inpatients occurred 12.3 times per 1000 patient admissions.<sup>15</sup>

Error rates are influenced by numerous factors, a few of which include the health care setting, route of drug administration, and

clinical scenario. For example, error rates are likely higher for drugs administered intravenously compared with other routes.<sup>9</sup> In the nursing home setting, the medication administration error rate—determined from direct observation in 58 nursing homes—was estimated to be 12.2%.<sup>16</sup> Errors of omission (for example, not giving aspirin after myocardial infarction) have been studied extensively in patients with acute coronary syndrome. The percentage of patients that are prescribed aspirin at hospital discharge after a myocardial infarction has ranged from 53% to 93.4%,<sup>9,17,18</sup> even though the current guidelines should yield a 100% rate if there is not a contraindication to aspirin. Transitions of patient care are particularly hazardous for introducing medication errors. Moore et al<sup>19</sup> discovered, by comparing inpatient and outpatient records, that 49% of patients discharged from a hospital had at least one medication error.

The frequency of harm relative to the frequency of medication errors has also been studied. Bates et al<sup>5</sup> studied more than 10,000 medication orders and identified 5.3 errors per 100 orders. However, they concluded that only 0.9% of the errors actually resulted in adverse drug events. Barker et al<sup>20</sup> studied medication errors at 36 institutions. They reported that 19% of the doses were in error; yet, only 7% were judged to potentially contribute to adverse drug events.

Voluntary reporting systems, including the US Food and Drug Administration (FDA) MedWatch, the Medication Error Reporting Program, and MEDMARX, are used to track medication errors. MEDMARX, introduced in 1998, uses a structured taxonomy to report and classify errors, and to date has received over 1 million entries. The top 10 drugs most commonly implicated in drug errors were (in descending order) insulins, albuterol, morphine, potassium chloride, heparin, cefazolin, furosemide, levofloxacin, and vancomycin.<sup>21</sup> The contributing factors related to these inpatient errors included but were not limited to staffing issues, distractions, workload increases, patient issues, shift changes, cross coverage, and fatigue.<sup>20</sup>

Budnitz et al<sup>22</sup> studied the National Electronic Injury Surveillance System to determine which medications are associated with the highest rates of emergency department visits due to adverse drug events. Although not always

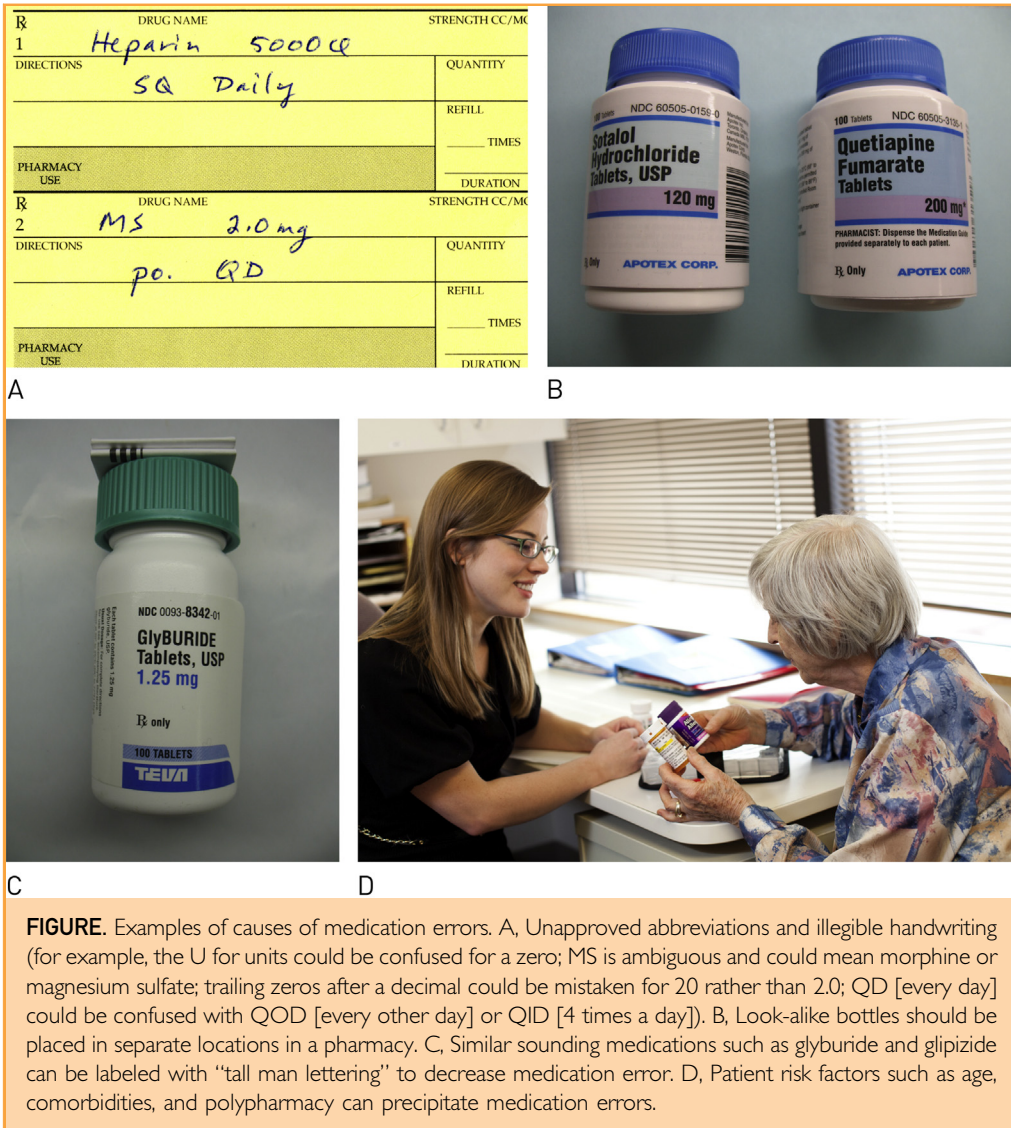
associated with an error, the patients in this series presented to the emergency department to receive care for a drug-related insult or harm. The 5 most commonly implicated drug classes, collectively accounting for 27.7% of the estimated adverse drug events, were insulins, opioid-containing analgesics, anticoagulants, amoxicillin-containing agents, and antihistamines/cold remedies.<sup>22</sup> The events included allergic reactions to drugs (33.5%), unintentional overdoses (32.1%), adverse drug effects not related to allergy (28.6%), secondary drug effects (3.5%), and vaccine reactions (2.3%). Many of these emergency department visits resulted in patient hospitalization. In the adverse drug events that required hospitalization, the investigators reported that the 5 most commonly implicated drug classes were anticoagulants, insulins, opioid-containing analgesics, oral hypoglycemic agents, and antineoplastic agents.<sup>22</sup> The authors discovered that drugs that are usually monitored on an outpatient basis for toxicity—ie, warfarin, insulin, and digoxin—accounted for 41.5% of adverse drug event hospitalizations.

#### RISK FACTORS FOR MEDICATION ERRORS

There are patient, health care professional, and medication factors that are associated with the risk of a medication error (Figure). Decline in patients' renal or hepatic function is associated with higher medication error rates.<sup>23</sup> Additionally, patients' impaired cognition, comorbidities, dependent living situation, nonadherence to medications, and polypharmacy may also increase the risk of medication errors.<sup>24</sup>

Advanced age is a patient-related risk factor for medication errors. The American Geriatrics Society Beers Criteria have been developed and regularly updated to alert health care professionals about potentially inappropriate medication use in older adults.<sup>25</sup> The most problematic medications are anticholinergics, sedatives, and those that may cause orthostatic hypotension. These factors can predispose elderly patients to potentially serious effects such as delirium or falls. However, the use of these medications in an elderly patient may be appropriate in some cases, and it is not clear which fraction of adverse effects relate to errors.

Health care professional—associated factors can lead to medication error. The use of abbreviations in prescribing and other communications



increases the risk of a medication error. To address this issue, the Joint Commission has published a list of medical abbreviations that should not be used.<sup>26</sup> Examples include IU (international units), which could be mistaken for IV (intravenous), and MS (morphine sulfate), which could be mistaken for MSO<sub>4</sub> (magnesium sulfate).<sup>26</sup> It is recommended that potentially confusing terms be completely written out rather than abbreviated.

Cognitive biases by health care professionals also may contribute to medication errors. Specifically, confirmation bias, which is the “tendency to look for evidence that supports an early working hypothesis,”<sup>27</sup> and lack of situational awareness are cognitive

errors that may lead to medication errors. For example, if a medication is usually stored in a specific compartment in a resuscitation cart, those that frequently use the cart may become accustomed to this location. If the location is changed, someone could mistake the drug in this location for the intended drug. The same substitution error may occur when frequent vendor changes for a given drug or the introduction of a replacement drug (eg, resulting from attempts to reduce drug costs or compensate for drug shortages)<sup>28</sup> introduce different label colors and images that, in turn, mimic labels within the same storage area. In such instances, health care professionals—particularly when working in a stressful environment in



which quick decisions are required—may have confidence that they have accurately confirmed the correct medication when in fact they have not.

Look-alike names and the therapeutic index of the medication can predispose to medication errors and subsequent harm. The Institute for Safe Medication Practices has published lists of look-alike drug names. Examples include dopamine/dobutamine, daunorubicin/doxorubicin, vincristine/vinblastine, and prednisone/prednisolone. The list was generated from medication error reporting programs, errors in the literature, and expert input. Examples of high-alert medications include cardiac antiarrhythmics, anticoagulants, inotropic medications, insulin, and opioids.

#### AVOIDING MEDICATION ERRORS

Because the root causes of medication errors are diverse, multiple strategies are required to prevent them. The FDA has worked to review confusing drug names, improve packaging, require identification bar codes, and educate patients.<sup>29</sup> Campaigns such as the “5 Rights of Medication Administration”—right drug, right patient, right dose, right route, right time—have been used with limited success. The elimination of cognitive bias in medicine is a difficult problem to overcome. Systems thinking (ie, using quality improvement methodologies to discover and correct root causes of problems rather than blaming an individual), error proofing (ie, a lean methodology term that means to design an environment in which a mistake cannot happen, such as a cable that can only be plugged into an outlet in one direction), and training have been suggested methods to remediate drug errors or opportunities for drug errors.<sup>27</sup>

Information technology has been a mainstay for reducing medication errors. Computerized systems can eliminate illegible handwriting and confusing medical abbreviations.<sup>30</sup> Drug databases can also help to identify drug-drug interactions.<sup>31</sup> Computerized physician order entry can decrease medication errors by more than one-half, although not all of these errors would have resulted in an adverse event.<sup>32</sup> In other research, a computerized physician order entry system helped reduce non—missed-dose medication errors in outpatients from 142 per 1000 patient-days at baseline to 26.6 per 1000

patient-days after the intervention.<sup>33</sup> Bar code—assisted medication administration was reported to reduce the medication error rate in an intensive care unit from 19.7% to 8.7% (a 56% reduction).<sup>34</sup> This medication error rate improvement was mostly due to reductions in errors of wrong administration time. Despite success at reducing medication errors, technology such as physician order entry and bar code—assisted administration systems require considerable financial investment, health care professional training, and system maintenance.<sup>32</sup>

Education for both patients and health care professionals is an important component of medication error reduction. Programs have been deployed to teach patients to maintain an accurate medication list, know the indications for each of their medicines, and bring medication bottles to all physician appointments.<sup>12</sup> Additionally, promotion of a culture of safety is important to improve error reporting. Preparation for medication error discovery and disclosure are now being taught to physicians and medical students.<sup>35</sup> Real-time education by pharmacists may also decrease errors. Pharmacist participation as a full member of a health care team on hospital rounds also is reported to decrease adverse drug events caused by prescribing errors.<sup>36</sup>

#### Drug Labeling

Drug labeling to help prevent medication errors is not a new idea. In historical apothecaries, poisons were kept in colored (often cobalt blue) bottles labeled with sinister warnings (skull and crossbones, “Not to Be Taken,” “POISON”). The bottles were also textured so that a pharmacist would have a tactile warning that the contents were toxic. Additionally, because most apothecary bottles were cylindrical, poison bottles were often a unique shape such as triangular or even in the shape of a coffin.

In a similar way, modern techniques to prevent medication errors have used concepts from human factors engineering. The goal of human factors engineering is to consider human nature and make systems that are “human proof.”<sup>27</sup> To help prevent confusion with look-alike drug names, the FDA and Institute for Safe Medical Practices have recommended the use of “tall man letters.”<sup>37</sup> For example, dopamine and dobutamine would be labeled as **DOP**amine

and DOBUTamine. Tall man lettering has the potential to mitigate medication errors for some of the most hazardous medications including pressors and oral hypoglycemic agents (GlyBURIDE and GliPIZIDE). Tall man lettering has the potential to avoid confusion of very different compounds, such as LaMICtal and LamISIL. However, studies have yielded mixed results on whether tall man lettering reduces medication errors.<sup>37,38</sup> For over-the-counter medications, the FDA has also worked to standardize labels to make them easier for patients to read.<sup>29</sup>

The FDA has started to review all drug names and work with drug companies to select names that avoid confusion.<sup>29</sup> The FDA has also started requiring that certain high-risk products—regardless of the source of risk for error—be bar coded so that checks can be put into place to ensure that the right medication is given to the right patient.<sup>29</sup>

### Medication Reconciliation

An accurate and complete medication list is often highly beneficial when providing medical care to a patient. *Medication reconciliation* is defined by the Institute for Healthcare Improvement as “a process of identifying the most accurate list of all medications a patient is taking—including name, dosage, frequency, and route—and using this list to provide correct medications for patients anywhere within the health care system.”<sup>39</sup> Medication reconciliation is a process that involves (1) verification of the patient’s medication history, (2) clarification that the medications are appropriate for the patient, and (3) reconciliation of any discrepancies.<sup>40</sup>

Medication reconciliation has received much attention from health care organizations. The Joint Commission made medication reconciliation one of its National Patient Safety Goals in 2005.<sup>41</sup> Reducing errors and harm from mislabeling medications and from anticoagulation have remained Joint Commission patient safety goals.<sup>42</sup> Additionally, Medicare and Medicaid have developed incentive payment programs for the “meaningful use” of the electronic health record. Stage 2 of meaningful use includes medication reconciliation as a core objective.<sup>43</sup>

Contrary to the logic that medication reconciliation must certainly be beneficial, the Cochrane Collaboration has performed a systematic review of the literature and concluded

that, at least in hospitalized patients, there currently is no convincing evidence that medication review reduces morbidity and mortality.<sup>44</sup> They elaborated that more clinical trials with rigorous methods will need to be completed before a more definitive conclusion can be made. Future trials should cover a multitude of different practice venues (eg, hospitals, nursing homes, outpatient facilities) and types of patients (eg, pediatric and elderly patients), given that benefits in one location and demographic may not translate to others.

## DISCLOSURE AND LEGAL CONSEQUENCES OF MEDICATION ERRORS

### Disclosure of Errors

Disclosure of medication errors is important for the benefit of an individual patient, as well as to provide data for broader, systemic insights into any recurring patterns of errors.<sup>21</sup>

Studies have examined patient attitudes toward disclosure of medical and medication errors. In general, patients and their families want transparent communication and full disclosure when an error occurs.<sup>45,46</sup> In addition, most patients want to know about an error even if there was no detrimental outcome, and they expect to be informed as soon as the error is discovered, told in person, given an apology, and informed of efforts to prevent future errors.<sup>46-48</sup> Alternatively, nondisclosure is reported to diminish patients’ trust in physicians and increase the likelihood they will change physicians.<sup>49</sup>

From the physician’s perspective, disclosure of a medical error can be anxiety-provoking because of fear of humiliation, reprimand, or litigation. Studies of physician disclosure of medical errors have found that there is physician variability about which errors to disclose (eg, harm vs near misses) and the use of apology.<sup>48</sup> Additionally, the specialty of the physician may affect whether the error is disclosed and how much detail is included.<sup>50</sup> As reviewed by Gallagher et al,<sup>50</sup> both medical and surgical specialists were less likely to disclose an error if it might not be apparent to the patient. However, surgeons were more likely to disclose an error but disclosed less information than a medical specialist.<sup>50</sup> Additionally, patients and physicians also have divergent definitions of a medical error. In general, patients tend to have more widely encompassing definitions of medical

errors, whereas physicians tend to have narrower definitions that focus primarily on deviations from standards of care.<sup>48</sup> Studies in resident physicians indicate that a minority had been formally prepared to disclose an error.<sup>51</sup>

The effects of full disclosure of medical errors on litigation have been studied. The University of Michigan Health System implemented and studied a program to fully disclose and offer compensation for medical errors and found that there was no increase in total claims or liability costs.<sup>52</sup> Full disclosure of errors also probably has a neutral to positive effect on the way a patient responds to an error and on the patient-physician relationship.<sup>49</sup>

### Legal Consequences

Common consequences faced by physicians after medication errors can include civil actions, criminal charges, and medical board discipline. According to the Texas Medical Liability Trust, an initiative endorsed by the Texas Medical Association, inappropriate prescribing of medication, to include medication errors, is among the top 10 reasons for physicians to be sued for medical malpractice.<sup>53</sup>

For a civil suit of medical malpractice to succeed against a health care professional, negligence must have resulted and the negligence must have resulted in injury to the patient. The injured party must prove that a standard of care existed, that the physician involved breached that standard, that an injury occurred as a result, and that the breach was a cause of the injury.<sup>54</sup>

For example, a nephrologist residing in Texas was assisting in the care of a 72-year-old patient undergoing kidney dialysis who was admitted to the hospital for a toe amputation.<sup>55</sup> During the patient's hospital course, the nephrologist wrote an order for 10 mmol of potassium chloride, to be administered by intravenous infusion. Feeling that 10 mmol was inadequate, he increased the dose requested to 20 mmol by writing the number 2 over the number 1, without scratching out the original number 1. The patient was then given a total of 120 mmol of potassium chloride instead of the expected 20 mmol. The patient had cardiac arrest and subsequently died. At trial, the defendant nephrologist argued that the 120 mmol dose was so out of the normal dosing

of potassium chloride that pharmacists and nurses at the hospital should have clarified the proper dosing with him before administering it to the patient.<sup>55</sup> The civil court jury awarded the family of the patient \$380,000 for the negligence on the part of the physician. The hospital had previously settled with the family for an undisclosed amount representing 90% of the blame for the mishap in dosing.<sup>55</sup>

Less commonly, criminal allegations may be filed against physicians when a medication error results in injury. Since the 1990s in the United Kingdom, there has been an increase in the number of physicians indicted for gross negligence manslaughter due to medication errors.<sup>56,57</sup> This upswing in cases is said to reflect society's "intolerance towards 'accidents' as being events that have an innocent origin."<sup>57</sup> This type of criminal penalty for medication errors is not limited to the United Kingdom. In August 2009, a pharmacist from Ohio, Eric Cropp, was sentenced to a prison term for involuntary manslaughter after the death of a 2-year-old child receiving chemotherapy.<sup>54</sup> The treatment medication was to be compounded using 0.9% sodium chloride but instead was mixed using hypertonic saline (23.4% sodium chloride). After intravenous administration, the young patient complained of a severe headache and fell limp in her mother's arms. She was placed on life support and diagnosed as brain dead from an overdose of sodium chloride. Mr Cropp was sentenced to 6 months of prison time and 6 months of home detention and was required to perform 400 hours of community service to include presenting to professional groups on the topic of medication errors and possible systems to help mitigate the risk to patient safety.<sup>54</sup>

Statutes and courts require a greater degree of culpability when charging a health care professional with negligent conduct under a criminal act when compared with a civil penalty. Under criminal negligence, the accused "should be aware of a substantial and unjustifiable risk that...will result from his conduct."<sup>42</sup> Furthermore, "the risk must be of such a nature and degree that the actor's failure to perceive it...involves a gross deviation from the standard of care that a reasonable person would observe in the actor's situation."<sup>42</sup> Other courts require gross negligence to be proven. Under this concept, the health care professional's actions must be more than inadvertent but just

**TABLE. Medication Errors: Summary of Key Points**

<p>Definitions</p> <ul style="list-style-type: none"> <li>• <i>Medication error</i>—any error occurring anywhere in the medication use process</li> <li>• <i>Adverse drug event</i>—an adverse outcome that can be attributed to the action of a drug</li> </ul>
<p>Incidence</p> <ul style="list-style-type: none"> <li>• Medication errors cause 1 of 131 outpatient and 1 of 854 inpatient deaths</li> <li>• Inpatient medication error rates are between 4.8% and 5.3%</li> <li>• Harm from medication errors is low (0.9% of medication errors)</li> <li>• Medications most commonly associated with errors include insulins, opioid-containing analgesics, anticoagulants, amoxicillin-containing agents, and antihistamines/cold remedies</li> </ul>
<p>Risk factors</p> <ul style="list-style-type: none"> <li>• <i>Patient factors</i>—decline in renal or hepatic function, impaired cognition, comorbidities, polypharmacy</li> <li>• <i>Health care professional factors</i>—use of abbreviations, cognitive biases</li> </ul>
<p>Avoiding medication errors</p> <ul style="list-style-type: none"> <li>• Computerized physician order entry</li> <li>• Bar code—assisted administration</li> <li>• Improved drug labeling</li> <li>• Medication reconciliation</li> </ul>
<p>Disclosure and legal consequences</p> <ul style="list-style-type: none"> <li>• Disclosure is most effective when there is transparent communication, full disclosure, and an apology</li> <li>• Consequences can include civil actions, criminal charges, and medical board discipline</li> </ul>

short of intentional behavior.<sup>58</sup> Either test used by the court has limited ability to trigger a culpable fault accusation (or charge) against a medical professional because most medication errors are more commonly considered “accidents.” Evolving public sentiments may increase the use of criminal standards (vs civil standards) in the future.

A third possible consequence of a medication error is regulatory board action.<sup>54</sup> Each state board of medical practice has unique administrative characteristics. The “primary responsibility and obligation of the [Minnesota] Board of Medical Practice (Board) is to protect the public...from the unprofessional, improper, incompetent, and unlawful practice of medicine...”<sup>59</sup> The Board is complaint-driven, requiring someone (eg, a patient, a family member, another health care professional, a pharmacist) to file a complaint before an investigation can be initiated. The Board is then obligated to investigate all complaints. If the Board determines that the minimal standard of care has not been met and that physician education can remedy the problem, education will be required. When a patient has been harmed, remedies are pursued to ensure that the physician works to improve his or her practice moving forward. If the event is sufficiently egregious, the Board has the power to suspend or revoke a physician’s

license (K. H. Berge, MD, vice president of the Minnesota Board of Medical Practice and Chair of the Complaint Review Committee, oral communication, May 21, 2013).

**CONCLUSION**

Medication error is an important cause of morbidity and mortality, yet it can be a confusing and underappreciated concept (Table). A medication error is any error that occurs in the medication use process. It has been estimated by the IOM that medication errors cause 1 of 131 outpatient and 1 of 854 inpatient deaths. Medication factors (eg, similar sounding names, low therapeutic index), patient factors (eg, poor renal or hepatic function, impaired cognition, polypharmacy), and health care professional factors (eg, use of abbreviations, cognitive biases) can precipitate medication errors. Common consequences faced by physicians after medication errors can include loss of patient trust, civil actions, criminal charges, and medical board discipline. Methods to prevent medication errors from occurring (eg, use of information technology, better drug labeling, and medication reconciliation) have been used with varying success. When an error is discovered, most patients expect disclosure that is timely, given in person, and accompanied with an apology and efforts to prevent future errors. Learning



more about medication errors may enhance health care professionals' ability to provide safe care to their patients. Future research should focus on identifying the errors that most commonly lead to patient harm. Additionally, a better understanding of how information technology, labeling, medication reconciliation, and improved care transitions reduce medication errors is needed. A focus on easy-to-use and inexpensive techniques for medication error reduction will likely have the greatest impact.

**Abbreviations and Acronyms:** FDA = Food and Drug Administration; IOM = Institute of Medicine

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## REFERENCES

- Kohn LT, Corrigan J, Donaldson Molla S, eds; Institute of Medicine Committee on Quality of Health Care in America. *To Err is Human: Building a Safer Health System*. Washington, DC: National Academy Press; 2000.
- Kaufman DW, Kelly JP, Rosenberg L, Anderson TE, Mitchell AA. Recent patterns of medication use in the ambulatory adult population of the United States: the Slone survey. *JAMA*. 2002; 287(3):337-344.
- Makaryus AN, Friedman EA. Patients' understanding of their treatment plans and diagnosis at discharge. *Mayo Clin Proc*. 2005;80(8):991-994.
- Jiménez Muñoz AB, Muiño Miguez A, Rodríguez Pérez MP, Escribano MD, Durán García ME, Sanjurjo Saez M. Medication error prevalence. *Int J Health Care Qual Assur*. 2010;23(3):328-338.
- Bates DW, Boyle DL, Vander Vliet MB, Schneider J, Leape L. Relationship between medication errors and adverse drug events. *J Gen Intern Med*. 1995;10(4):199-205.
- Blendon RJ, DesRoches CM, Brodie M, et al. Views of practicing physicians and the public on medical errors. *N Engl J Med*. 2002; 347(24):1933-1940.
- Aronson JK, Ferner RE. Clarification of terminology in drug safety. *Drug Saf*. 2005;28(10):851-870.
- Institute of Medicine. *Patient Safety: Achieving a New Standard for Care*. Washington, DC: National Academies Press; 2004.
- Institute of Medicine. *Preventing Medication Errors: Quality Chasm Series*. Washington, DC: National Academies Press; 2007.
- World Health Organization. *Pharmacovigilance: Ensuring the Safe Use of Medicines*. Geneva, Switzerland: World Health Organization; 2004:6. WHO Policy Perspectives on Medicines 9.
- Edwards IR, Aronson JK. Adverse drug reactions: definitions, diagnosis, and management. *Lancet*. 2000;356(9237): 1255-1259.
- ASHP guidelines on preventing medication errors in hospitals. *Am J Hosp Pharm*. 1993;50(2):305-314.
- Aronson JK. Medication errors: definitions and classification. *Br J Clin Pharmacol*. 2009;67(6):599-604.
- National Coordinating Council for Medication Error Reporting and Prevention. NCC MERP Index for Categorizing Medication Errors. [www.nccmerp.org/medErrorCatIndex.html](http://www.nccmerp.org/medErrorCatIndex.html). Revised February 20, 2001. Accessed March 17, 2014.
- Lesar TS. Prescribing errors involving medication dosage forms. *J Gen Intern Med*. 2002;17(8):579-587.
- Barker KN, Mikeal RL, Pearson RE, Illig NA, Morse ML. Medication errors in nursing homes and small hospitals. *Am J Hosp Pharm*. 1982;39(6):987-991.
- Krumholz HM, Chen J, Rathore SS, Wang Y, Radford MJ. Regional variation in the treatment and outcomes of myocardial infarction: investigating New England's advantage. *Am Heart J*. 2003;146(2):242-249.
- Granger CB, Steg PG, Peterson E, et al; GRACE Investigators. Medication performance measures and mortality following acute coronary syndromes. *Am J Med*. 2005; 118(8):858-865.
- Moore C, Wisnivesky J, Williams S, McGinn T. Medical errors related to discontinuity of care from an inpatient to an outpatient setting. *J Gen Intern Med*. 2003;18(8):646-651.
- Barker KN, Flynn EA, Pepper GA, Bates DW, Mikeal RL. Medication errors observed in 36 health care facilities. *Arch Intern Med*. 2002;162(16):1897-1903.
- Vecchione A. USP Drug Safety Review: Top 10 drugs involved in medication errors. Drug Topics website. <http://drugtopics.modernmedicine.com/drug-topics/news/usp-drug-safety-review-top-10-drugs-involved-medication-errors>. Published December 8, 2003. Accessed March 17, 2014.
- Budnitz DS, Pollock DA, Weidenbach KN, Mendelsohn AB, Schroeder TJ, Annet JL. National surveillance of emergency department visits for outpatient adverse drug events. *JAMA*. 2006;296(15):1858-1866.
- Lesar TS, Briceland L, Stein DS. Factors related to errors in medication prescribing. *JAMA*. 1997;277(4):312-317.
- Leendertse AJ, Egberts AC, Stoker LJ, van den Bemt PMLA; HARM Study Group. Frequency of and risk factors for preventable medication-related hospital admissions in the Netherlands. *Arch Intern Med*. 2008;168(17):1890-1896.
- Fick DM, Semla TP. 2012 American Geriatrics Society Beers Criteria: new year, new criteria, new perspective. *J Am Geriatr Soc*. 2012;60(4):614-615.
- The Joint Commission. Facts about the Official "Do Not Use" List of Abbreviations. The Joint Commission website. [http://www.jointcommission.org/facts\\_about\\_the\\_official\\_/](http://www.jointcommission.org/facts_about_the_official_/). Published June 18, 2013. Accessed March 17, 2014.
- Leape LL. Error in medicine. *JAMA*. 1994;272(23):1851-1857.
- Fox ER, Sweet BV, Jensen V. Drug shortages: a complex health care crisis. *Mayo Clin Proc*. 2014;89(3):361-373.
- US Food and Drug Administration. FDA 101: medication errors. <http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm048644.htm>. Updated February 20, 2009. Accessed March 17, 2014.
- Milani RV, Oleck SA, Lavie CJ. Medication errors in patients with severe chronic kidney disease and acute coronary syndrome: the impact of computer-assisted decision support. *Mayo Clin Proc*. 2011;86(12):1161-1164.
- Seminario MJ, Ratain MJ. Preventing adverse drug-drug interactions: a need for improved data and logistics [editorial]. *Mayo Clin Proc*. 2013;88(2):126-128.
- Bates DW, Leape LL, Cullen DJ, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA*. 1998;280(15):1311-1316.
- Bates DW, Teich JM, Lee J, et al. The impact of computerized physician order entry on medication error prevention. *J Am Med Inform Assoc*. 1999;6(4):313-321.
- DeYoung JL, Vanderkooi ME, Barletta JF. Effect of bar-code-assisted medication administration on medication error rates in an adult medical intensive care unit. *Am J Health Syst Pharm*. 2009;66(12):1110-1115.
- Taekman JM, Hobbs E, Wright MC. Intraoperative apnea: medication error with disclosure (simulation case scenario). *Simul Healthc*. 2007;2(1):39-42.
- Leape LL, Cullen DJ, Clapp MD, et al. Pharmacist participation on physician rounds and adverse drug events in the intensive care unit [published correction appears in *JAMA*. 2000; 283(10):1293]. *JAMA*. 1999;282(3):267-270.

37. Filik R, Purdy K, Gale A, Gerrett D. Labeling of medicines and patient safety: evaluating methods of reducing drug name confusion. *Hum Factors*. 2006;48(1):39-47.
38. Irwin A, Mearns K, Watson M, Urquhart J. The effect of proximity, Tall Man lettering, and time pressure on accurate visual perception of drug names. *Hum Factors*. 2013;55(2):253-266.
39. Institute for Healthcare Improvement. Medication reconciliation review. <http://www.ihf.org/knowledge/Pages/Tools/MedicationReconciliationReview.aspx>. Accessed March 17, 2014.
40. Manno MS, Hayes DD. Best-practice interventions: how medication reconciliation saves lives. *Nursing*. 2006;36(3):63-64.
41. Varkey P, Cunningham J, Bisping DS. Improving medication reconciliation in the outpatient setting. *Jt Comm J Qual Patient Saf*. 2007;33(5):286-292.
42. Model Penal Code § 2.02(2)(d).
43. HealthIT.gov. Step 5: Achieve Meaningful Use Stage 2: Medication Reconciliation. <http://www.healthit.gov/providers-professionals/achieve-meaningful-use/core-measures-2/medication-reconciliation>. Accessed March 17, 2014.
44. Christensen M, Lundh A. Medication review in hospitalised patients to reduce morbidity and mortality. *Cochrane Database Syst Rev*. 2013;2:CD008986.
45. Hobgood C, Tamayo-Sarver JH, Elms A, Weiner B. Parental preferences for error disclosure, reporting, and legal action after medical error in the care of their children. *Pediatrics*. 2005;116(6):1276-1286.
46. Mazor KM, Simon SR, Yood RA, et al. Health plan members' views about disclosure of medical errors. *Ann Intern Med*. 2004;140(6):409-418.
47. Wu AW, Cavanaugh TA, McPhee SJ, Lo B, Micco GP. To tell the truth: ethical and practical issues in disclosing medical mistakes to patients. *J Gen Intern Med*. 1997;12(12):770-775.
48. Gallagher TH, Waterman AD, Ebers AG, Fraser VJ, Levinson W. Patients' and physicians' attitudes regarding the disclosure of medical errors. *JAMA*. 2003;289(8):1001-1007.
49. Mazor KM, Reed GW, Yood RA, Fischer MA, Baril J, Gurwitz JH. Disclosure of medical errors: what factors influence how patients respond? *J Gen Intern Med*. 2006;21(7):704-710.
50. Gallagher TH, Garbutt JM, Waterman AD, et al. Choosing your words carefully: how physicians would disclose harmful medical errors to patients. *Arch Intern Med*. 2006;166(15):1585-1593.
51. White AA, Gallagher TH, Krauss MJ, et al. The attitudes and experiences of trainees regarding disclosing medical errors to patients. *Acad Med*. 2008;83(3):250-256.
52. Kachalia A, Kaufman SR, Boothman R, et al. Liability claims and costs before and after implementation of a medical error disclosure program. *Ann Intern Med*. 2010;153(4):213-221.
53. Texas Medical Liability Trust. *10 Things That Get Physicians Sued*. Austin, TX: Texas Medical Liability Trust; 2010. <http://resources.tmlt.org/PDFs/ten-things-that-get-physicians-sued.pdf>. Accessed March 17, 2014.
54. McCarthy K. Medication Errors and Public Safety: Tragic Consequences When the System Breaks Down. [http://www.freece.com/Files/Classroom/ProgramSlides/26b4c4c3-1ada-4034-80df-a999a2dc2a53/updated\\_documentbody\\_cp.pdf](http://www.freece.com/Files/Classroom/ProgramSlides/26b4c4c3-1ada-4034-80df-a999a2dc2a53/updated_documentbody_cp.pdf). Published May 16, 2011. Accessed March 17, 2014.
55. Kapitan C. Poor penmanship costs doctor \$380,000. *San Antonio Express-News* website. <http://www.mysanantonio.com/business/health-care/article/Jury-Doc-s-sloppy-handwriting-factored-in-fatal-4866905.php>. Updated October 4, 2013. Accessed March 17, 2014.
56. Femer RE. Medication errors that have led to manslaughter charges. *BMJ*. 2000;321(7270):1212-1216.
57. Holbrook J. The criminalisation of fatal medical mistakes [editorial]. *BMJ*. 2003;327(7424):1118-1119.
58. Gross negligence. Law.com website. <http://dictionary.law.com/Default.aspx?selected=838>. Accessed March 17, 2014.
59. State of Minnesota. Medical Practice Act Work Group Report. <http://mn.gov/health-licensing-boards/images/Medical%20Practice%20Act%20Work%20Group%20Final%20Report.pdf>. Published January 2013. Accessed March 17, 2014.