Medical Errors

Learning Objectives

After successfully completing this training, the reader will have a better understanding of:

- What is a medication error?
- Differentiate between documentation errors, equipment errors, patient errors, missed treatments and communication errors.
- What contributes to medication errors in the elderly?
- What drugs are associated with medication errors?
- How can medication errors be prevented?
Introduction

Medical errors in the United States are costly in terms of dollars and human quality of life. They result in millions of unneeded extra hospitalized patient days per year, $9.3 billion in excess charges a year, and over 180,000 deaths a year. Hospitalizations related to drug side effects or adverse events account for 2.4 to 6.5 per cent of medical admissions. This number is higher in elderly patients who take more medications and are less resilient than younger patients.

Medical errors can be confusing to the lay public. Normal side effects can be distressing to the unprepared patient. These distressing effects of treatment may not be related to medical error and can occur during the best chosen and monitored treatment regimens. Some treatments are associated with a low but significant proportion of adverse events. Not all diseases can be cured or resolved to meet the expectation of the patient.

Different types of errors have been described and a standard terminology in the medical and legal systems has not been developed. Terms commonly found when evaluating medication errors include:

**Active error:** An error in the delivery of medical care to the patient that has an immediately recognized effect on the patient.

**Adverse event:** An injury resulting from medical treatment. The injury can be short lasting to permanent, preventable or not preventable, expected or unexpected.

**Failure Modes and Effects Analysis:** FMEA is a tool used to analyze system failures and identify their effects on system operations. The analysis includes a prioritization of risks in order to assign resources to the most significant system flaws.

More than 180,000 deaths a year are caused by medical errors. About 7,000 of those deaths are caused by medication errors alone! This report will summarize the most common failures associated with medical errors, the commonly used drugs that are more often associated with medication errors. It also looks at the increased risk of elderly patients and medical errors and finally strategies for prevention of medical errors.
**Latent error:** An error in the delivery of medical care to the patient that has a delayed effect on the patient. Administration of an erroneous drug dose leading to cumulative toxicity over time would be a latent error. Lost, misplaced, or non-decipherable medical records are an everyday example of a latent error. Latent medical errors do not cause immediate harm to the patient even though they may be ongoing for an extended period of time. Latent Errors can lead to Active Errors.

**Medical error:** A mistake in the choice or implementation of a treatment plan, choice of drug, or other action that will impact the patient.

**Medical reconciliation:** A formal review of the patient’s list of current medications and comparison with the list in the medication orders. This serves as a safety check for drugs received. It is particularly useful during patient transfer from home to the hospital, from the hospital to home, from the home or the hospital ward to the ICU, or from the ICU to the hospital ward.

**Medication error:** A preventable mistake in the implementation of drug treatment that may involve choice of drug, dosage, timing of administration, compounding of the drug, labeling of the drug, patient education regarding use of the drug and its side effects, and monitoring of the patient. This type of error may or may not be associated with an adverse event. One potential adverse event is treatment with a drug that is not active against the disease being treated. A medication error can be result from a mistake made by the treating physician, teaching nurse, pharmacist, or patient.

**Mistake:** An error in judgment.

**Near miss/Close call:** A chain of events leading up to a Medical Error that is broken before the error can occur. The chain can be broken by recognition of the error or by chance. This type of “near error” may point to a flaw in the chain of medical care delivery that needs attention or correction.

**Prescription Cascade:** The prescription of a new drug or drugs to treat symptoms arising from an unrecognized adverse drug related event. The prescription of additional drugs increases the risk of undesired drug interactions. A common example would be the development of extrapyramidal signs and symptoms after treatment with antipsychotics, resulting in the addition of anti-parkinsonian therapy to the patient’s treatment regimen.

**Risk Priority Number:** A number calculated during FMEA to estimate the significance of a failure event. RPN is calculated as:
RPN = event cost x probability of event occurring x ability to detect the event

**Sentinel event:** An unexpected serious adverse event, including death, serious physical injury, and serious psychological injury.

**Unpreventable adverse event:** An adverse event related to and expected with the treatment course prescribed that cannot be prevented. An example would be significant decreases in the white blood cell count during certain forms of chemotherapy.

**Medication Errors**

About 10% of medication errors result in adverse events. *The Institute of Medicine has estimated that about 7,000 Americans die from medication errors each year.* About a quarter million elderly patients are hospitalized yearly with drug reactions between their prescription and over-the-counter medications. Seven failures have been reported to account for 78% of medication errors. The most common reasons were insufficient caregiver knowledge, lack of patient clinical information, prescribing drugs the patient was allergic to, and errors during administration by nurses. Most of these errors are related to the ordering and administration of the prescription.

The most common error was related to insufficient caregiver information regarding the prescribed drug. Given the huge growth in drugs available for use—a 500% increase in the last 10 years—considerable effort must be used to remain current. The strategy of using the same group of drugs is not practical and not beneficial to all patients. Continuing education is needed to maintain a working knowledge of available pharmaceuticals. In-house educational programs, consultation with other physicians and meeting with pharmaceutical representatives can be used to keep current with new drugs. Numerous hand-held electronic devices and Internet Web sites are available for “on the fly” consultation.

Missing or unavailable clinical information regarding individual patients can lead to medication errors during treatment. Unusual sensitivity to a drug previously prescribed, a history of idiosyncratic reactions, or drug allergy can be overlooked. Medical records can have missing information regarding medications or incorrect medications listed. Studies of the accuracy of medical records have identified at least one error in 60% of medical records and 18% of medical records had three or more errors. One third of medication errors are related to the prescription of drugs the patient is
allergic to. The use of electronic prescription systems has reduced this type of error. Electronic confirmation systems store allergy data and allow confirmation of allergies. They also prevent administration of commonly recognized drugs that would be associated with allergy. More sophisticated systems provide a list of drugs that may result in an allergic reaction.

Commonly taken drugs are more often associated with an adverse event. The 10 drugs most commonly associated with adverse events are listed in Table 1, from most common to least common. Patients were exposed in the community and treated in the emergency room. The misuse of NSAIDs (nonsteroidal anti-inflammatory drugs), for example, leads to 16,000 deaths per year and 103,000 hospitalizations with the expected side effects of peptic ulcer disease and gastrointestinal bleeding.

<table>
<thead>
<tr>
<th>Table 1. Drugs Most Commonly Associated with Adverse Events in the Emergency Room</th>
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<tbody>
<tr>
<td>1. Insulin</td>
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<tr>
<td>2. Anticoagulants</td>
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<tr>
<td>3. Amoxicillin</td>
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<tr>
<td>4. Aspirin</td>
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<tr>
<td>5. Trimethoprim-sulfamethoxazole</td>
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<tr>
<td>6. Hydrocodone/acetaminophen</td>
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<tr>
<td>7. Ibuprofen</td>
</tr>
<tr>
<td>8. Acetaminophen</td>
</tr>
<tr>
<td>9. Cephalexin</td>
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<tr>
<td>10. Penicillin</td>
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</table>

The 10 drugs most commonly associated with adverse events in the hospital are listed in Table 2 (next page). Drugs are listed from most commonly associated with adverse events to least commonly associated events. Insulin was most common, comprising 4% of all errors in 2005. Errors were often related to confusing products with similar packaging or names and confusing the abbreviation "u" (for units) with the number 0. The Institute for Safe Medication Practices has identified these errors as ongoing problems for more than 30 years. (see Table 2 next page)
Morphine was the second most common in-hospital administered drug associated with adverse events. Like insulin, there can be similarly named products (oxycodone vs oxycodone ER, Oxycontin vs. MS Contin, hydrocodone vs. oxycodone, morphine vs hydromorphone) with different actions. Acetaminophen is widely used. It is available in different strengths alone and in combinations with other drugs. Acetaminophen-induced liver toxicity has been associated with about 40% of acute liver failure cases in the US. Of particular concern for respiratory therapist will be Albuterol at number four.

The Institute for Safe Medication Practices is a nonprofit organization whose mission is to prevent medication errors and promote safe medication use. The Institute has published a list of 10 factors that contribute to medication errors (Table 3). These factors are based on systematic errors that can be addressed to support proper choices and correct dosing of patients.

Table 3. Factors Contributing to Medication Errors

- Lack of patient information such as age, weight, or drug allergy history
- Not consulting prescription data sheets
- Lack of communication between caregivers and the patient
- Confusing or inadequate drug labeling, packaging, or naming
- Lack of drug standardization
- Lack of or inadequate medication delivery systems
- Pharmacy or drug room related factors such as poor lighting, crowded shelves, understaffing, or overburdened staff
- Lack of patient education
- Lack of a quality assurance and risk management program
- Lack of caregiver education
**Communication Errors**

Administration of prescribed medications involves a chain of events linking the treating physician with the patient, the nurse or therapist, and the pharmacist. Any break in this link can result in a medication error. Wrong choice of drug reflects inadequate knowledge on the part of the physician. The drug prescribed may be inappropriate, have known intolerable side effects for the particular patient, be an allergen, or be a “mix-up”. These errors may be related to physician choice, availability of patient records, or illegible physician prescriptions.

Nurses are frequently required to administer prescribed medicines, often without direct contact with the prescribing physician. Performance of these duties without validation of the treatment plan introduces a risk to subsequent links in the chain. An uncomfortable analogy is the children’s game where a word is whispered from one person to the next. The final product spoken is usually not the original word chosen. Fortunately, medical records and treatment context usually prevent such miscommunications, but errors still occur through an extended communication chain.

At one hospital surveyed, 64.65% of nurses admitted to some type of administration error. Moreover, 31.4% of these nurses also reported that they had a Near Miss. Incorrect drug dosage and incorrect infusion rates were the most common errors reported. The nurses’ most common explanations for these errors were physician use of nonstandard abbreviations, resulting in the wrong drug being administered, and the administration of drugs with similar names. Better knowledge of the drugs they were administering may have prevented these errors. No relationship was found between nurse age, hospital shift, nurse experience with the disease treated, or length of nurse’s career and frequency of nursing errors. When nurses dispense prescribe drugs, their unique position in the patient treatment chain allows them to identify potential treatment errors and advocate for patient safety.

Electronic data systems can solve many communication problems. A free internet based system is offered by the National e-Prescribing Patient Safety Initiative for the purpose of decreasing the incidence of preventable medication errors. This system provides a legible prescription to the pharmacy in a rapid, efficient manner. The system facilitates drug choice and dose choice and provides knowledge regarding side effects.
Medication Errors in the Elderly

Drug therapy in the elderly is more complicated because of the changes in physiologic and mental conditions that occur with aging. The elderly are frailer, have more medical problems, more memory issues, and are prescribed more medications than younger patients. There are approximately 100,000 hospitalizations each year due to adverse drug events in the elderly. Two-thirds of these are related to accidental overdoses. Older adults are four times more likely to be admitted for adverse drug events than younger patients. About 90% of events are thought to be preventable. The elderly are thus at increased risk for adverse drug events and medication errors. Arriving at a safe dose schedule may require planning or trial and error. Any changes in mental status or new symptoms should be examined to identify a medication related source. Because of these problems, the elderly require more monitoring and education regarding their medications than younger patients.

The use of newly marketed drugs may be problematic in the elderly. Drug development studies are generally performed with healthy younger volunteers, or at least patients with an intact physiologic status. Prescribing these drugs in the elderly can require a dose modification outside the drug development parameters. The elderly tend to have an increased volume of drug distribution related to an increase in body fat and loss of skeletal muscle associated with aging. Drug clearance may decrease as renal function declines with age. These two findings lead to an increased plasma concentration of many medications. Penicillins can have a larger volume of distribution and digoxin a lower clearance rate. Both can be associated with a higher than desired blood level in the elderly. Another consequence of aging may be increased sensitivity to some drugs, such as sedatives and narcotics. These types of altered metabolism and sensitivity necessitate more cautious administration of prescription drugs in the elderly.

Prescription medications are more commonly used in the elderly, with one prescriptions used by at least 80% of the elderly population and five or more prescription medications by about 30% of the elderly population. Almost half the elderly also take one or more non-prescription medications. Twenty percent of Medicare recipients have five or more chronic conditions and about half take five or more medications. The use of multiple prescription drugs is an independent risk factor for an adverse drug event at all ages, and particularly in the elderly. The use of multiple drugs increases the risk of drug interactions and decreases patient compliance.
Anticholinergic medications and sedatives have been associated with impaired cognitive ability and impaired mobility in the elderly. Other adverse effects include glaucoma, confusion, hallucinations, dry mouth, blurred vision, constipation, nausea, urinary retention, and tachycardia. When these drugs are removed from the list of prescriptions used in the elderly, the correlation between the number of medications and increased risk of adverse events disappears.

The Drug Burden Index was developed to calculate the magnitude of risk to patients. It takes into consideration drugs with anticholinergic or sedative activity, the doses prescribed, and the total number of medications. A higher drug burden is associated with a decreased Short Physical Performance Battery Score, decreased gait speed and decreased grip strength. The Anticholinergic Risk Scale (ARS) score is calculated by adding up the point score of medications the patient is taking (Table 4). A higher ARS score correlates with an increased risk of adverse effects in an elderly population (crude relative risk, 1.5; 95% confidence interval, 1.3-1.8).

<table>
<thead>
<tr>
<th>Table 4. Anticholinergic Drug Scale</th>
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<tr>
<td><strong>3 points</strong></td>
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<tr>
<td>Amitriptyline</td>
</tr>
<tr>
<td>Atropine</td>
</tr>
<tr>
<td>Benztropine</td>
</tr>
<tr>
<td>Carisoprodol</td>
</tr>
<tr>
<td>Chlorpheniramine</td>
</tr>
<tr>
<td>Chlorpromazine</td>
</tr>
<tr>
<td>Cyproheptadine</td>
</tr>
<tr>
<td>Dicyclomine</td>
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<tr>
<td>Diphenhydramine</td>
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<tr>
<td>Fluphenazine</td>
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<tr>
<td>Hydroxyzine</td>
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<tr>
<td>Hyoscyamine</td>
</tr>
<tr>
<td>Imipramine</td>
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<tr>
<td>Meclizine</td>
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<tr>
<td>Oxybutynin</td>
</tr>
<tr>
<td>Perphenazine</td>
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<tr>
<td>Promethazine</td>
</tr>
<tr>
<td>Thoridazine</td>
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<tr>
<td>Thiothixene</td>
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<tr>
<td>Tizanidine</td>
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<td>Trifluoperazine</td>
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Side effects of prescribed drugs are sometimes interpreted as a new malady or effect of aging in elderly patients taking medications. These side effects can be difficult to distinguish from new medical disorders and can result in the prescription of additional medications, a so called Prescription Cascade (Figure 1 below). One of the most common examples of a Prescription Cascade is the prescription of antipsychotic drugs or metoclopramide to treat Parkinsonism. The development of (expected) orthostatic hypotension and delirium can require additional treatment if they are not recognized as side effects. Similarly, patients receiving antipsychotic medications were 5.4 times (95% CI: 4.8-6.1) more likely to be prescribed anti-Parkinson medications than patients not receiving such treatment.

**Figure 1. Examples of Prescription Cascades**

<table>
<thead>
<tr>
<th>Initial Drug Therapy</th>
<th>Adverse Event</th>
<th>Treatment for Adverse Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antipsychotics</td>
<td>Extrapyramidal signs/symptoms</td>
<td>Antiparkinsonian therapy</td>
</tr>
<tr>
<td>Cholinesterase inhibitors</td>
<td>Urinary retention/incontinence</td>
<td>Treatment for Obstruction or Incontinence</td>
</tr>
<tr>
<td>Thiazide diuretics</td>
<td>Hyperuricemia</td>
<td>Gout treatment</td>
</tr>
<tr>
<td>NSAIDs</td>
<td>Elevated blood pressure</td>
<td>Antihypertensives</td>
</tr>
</tbody>
</table>

Because the elderly more often take multiple medications, they are more vulnerable to drug interactions. Common drug interactions are listed in Table 5 (next page). These reactions are often dose related. Care must be taken when multiple drugs are prescribed to avoid renal insufficiency, altered hepatic function, and the effects the proposed drug can have on drug metabolism in these organs.

About 40% of adults in long term care have renal insufficiency. Creatinine clearance gives a better estimate of renal function in the elderly as their muscle mass decreases with age. Dosing guidelines are readily available for these adjustments and commonly indicated. Over half of elderly patients with mild renal insufficiency were reported to require dose adjustments. Administration of renally cleared drugs in the elderly is best started at low doses and gradually increased as side effects or drug levels permit. Periodic
patient review will identify changes in drug clearance or symptoms that may indicate a needed change in prescription dose.

<table>
<thead>
<tr>
<th>Drug 1</th>
<th>Drug 2</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coumadin</td>
<td>NSAIDs, SSRIs, omeprazole, lipid lowering drugs, amiodarone or fluorouracil</td>
<td>Increased risk of bleeding</td>
</tr>
<tr>
<td>Glyburide</td>
<td>Co-trimazole</td>
<td>6 X ↑ Hypoglcemia</td>
</tr>
<tr>
<td>Digoxin</td>
<td>Clarithromycin</td>
<td>12 X ↑ Digoxin toxicity</td>
</tr>
<tr>
<td>ACE inhibitor</td>
<td>Potassium sparing diuretic</td>
<td>20 X ↑ Hyperkalemia</td>
</tr>
</tbody>
</table>

**Dietary Supplements and Herbal Medications**

The elderly are more commonly using dietary supplements. About half of older individuals polled in 2006 admitted to taking some supplement or herbal medicine. In one study, about 75% of elderly patients were taking at least one prescription medication and at least one dietary supplement. Seventy-five percent of elderly patients did not feel these supplements were relevant and did not report them to their physician. Dietary supplements have the potential to alter the metabolism of prescription drugs, leading to an increased likelihood of an adverse event. Obtaining the history of dietary supplements taken has become an essential part of the clinical history in the elderly.

Passage of the Dietary Health and Supplements act of 1994 allowed manufacturers to label their products with limited functional claims, expanding their appeal and contributing to their acceptance. Herbal remedies are considered food products under this act and so are not subjected to the same rigorous testing that pharmaceutical are. There are few regulations controlling the manufacture of these products, leading to great variation in quality. These factors have contributed to an increased incidence of adverse reactions in patients taking these compounds. Toxic herbs, herb overdoses, idiosyncratic reactions, allergic responses, and drug-herb interactions have been described.

Dietary supplements, in particular herbal medicines, can have physiologic activity that affects patient health and patient metabolism of prescribed drugs. Unpredicted interactions with prescribed drugs can lead to adverse drug events and are a form of Medication Error.

Gingko biloba is a common and useful example, Gingko is taken for its potential benefits with dementia, Alzheimer’s disease, memory, anxiety, intermittent claudication, premenstrual syndrome, Raynaud’s and macular
degeneration. It is generally considered as safe. However, taking Gingko can occasionally be associated with gastrointestinal discomfort, nausea, vomiting, diarrhea, headaches, dizziness, heart palpitations and restlessness. Unfortunately, these side effects can and are often interpreted as being caused by prescription medications.

Gingko is metabolized by the liver and can slow the metabolism of prescribed drugs also metabolized by the liver. Adverse events may develop due to increased blood concentrations of anticoagulants like Coumadin, aspirin or NSAIDs. Gingko can also affect monoamine oxidase activity, leading to increased levels of antidepressants with monoamine oxidase inhibitor or selective serotonin reuptake inhibitor activity. Other occasionally reported interactions include inhibition of anti-seizure drug activity (carbamazepine, valproic acid), excessive lowering of blood pressure (nifedipine), inhibition of anti-anxiety drug activity (Xanax), and increases or decreases in insulin and blood sugar levels. The activity of each dietary supplement and herbal medication requires careful scrutiny during clinical review.

**Critical Care Medication Errors**

An ICU contains high-risk patients requiring invasive medical interventions. It has been estimated that there are 1.7 errors per patient per day in the ICU. About 20% of medication errors in the ICU are life-threatening and about 40% require medical intervention to correct the event. The risk of an adverse event related to drug administration has been reported to increase by about 6% per patient per day. As with patients in the community, drugs most commonly used in the ICU are most often associated with an error on administration. These include potassium chloride, heparin, magnesium sulfate, vasoactive drugs, sedatives and analgesics.

Studies of ICU patients have identified several risk factors for medication errors:

- **The severity of patient illness is the greatest predictor of medication error in the ICU.**
- The ICU environment is fast paced, stressful, and there are frequently multiple caregivers.
- ICU patients are prescribed more medications than patients outside the ICU.
- ICU patients usually receive intravenous medications rather than oral, so the medication dosages are based on weight. These leads to errors in calculations. Similar errors can occur during the programming of infusion pumps.
- Critically ill patients are less able to tolerate errors in drug dosages, and are more at risk for an adverse reaction from them than non-ICU patients.
- ICU patients are often sedated and cannot communicate the reaction to medications to their caregivers.
Strategies have been developed to decrease the incidence of medication errors in the ICU, similar to those used in pharmacies and in general practice. The use of standardized medications with standard doses simplifies drug choice and administration in the ICU. Computerized pharmacy and clinical data access facilitates the choice of drugs and the calculation of drug doses. The use of bar code labels prevents misidentification of drugs and their administration. Computerized infusion devices facilitate dosing and monitoring of drug administration. A formal review of the patient’s list of current medications and comparison with the list in the medication orders, so called medical reconciliation, serves as a safety check for drugs received.

Caregiver errors can be reduced by decreasing work stress and increasing the review process. Prolonged shift work and excessive working hours should be avoided. Caregivers should have dedicated time when preparing medications, with a minimum of distractions and interruptions. New staff member need adequate supervision, certification for different prescription services, and a step-wise introduction to their new responsibilities. An appropriate nurse and resident to patient ratio will facilitate these processes, decreasing caregiver fatigue and sleep deprivation. Pharmacist, intensivist, and nursing participation in these decisions will provide an independent review of the prescription process and introduce a quality assurance process. The addition of an intensivist to the medical prescription team may reduce medication errors from 22 to 70% and decrease medication related adverse events by 50%. ICU mortality, duration of ICU stay, and duration of hospital stay improve with the addition of an intensivist to the ICU team.

The addition of a pharmacist to ICU rounds improves caregiver knowledge, improves drug treatment choice, and decreases preventable adverse events by 66%. Pharmacist participation is also associated with a shorter patient hospital stay, lower patient mortality, and lower prescription costs.

The common factor in medication errors is the human factor. The development of multiple safeguards and checks by independent sources will help decrease these errors. The automation of some of the steps involved in prescription delivery removes the human factor. The use of error reporting can serve as a focus to identify risky steps in this process, leading to changes in the process. Error reporting includes the reporting of Adverse Events and Near Miss events. Error reporting can be used as a teaching tool to prevent repetition of (near) errors.
Medication reconciliation is a useful technique to ensure proper medication when a patient is transferred from one environment to another. About 75% of patient prescriptions are stopped when a patient is transferred to an ICU. It has been reported that 88% of these prescriptions were not restarted when the patient left the ICU and 30% were still not restarted when the patient left the hospital.

Improved safety conditions have been reported in numerous industries after the introduction of standardized practices and a program of safety training. Current practices to avoid medication errors are still wanting. Further work is needed in identifying systematic sources of errors and developing resilient solutions.

**Medication Errors in the Operating Room**

Medication Errors in the operating room most frequently affect children. 13% of such errors resulted in patient harm, higher than in adult groups. These errors are most often due to dose calculation errors. National and International standards are followed to ensure proper caregiver training, accurate record keeping, and that equipment is well maintained, patients are accurately evaluated, intraoperative monitoring is carefully performed and postoperative care is well monitored.

Patients undergoing surgery frequently receive antibiotic prophylaxis. Absence or incorrectly administered antibiotics have been associated with an increased risk of infection. Correct administration of antibiotics is performed 10 to 60 minutes before the skin incision is made in order to ensure adequate tissue levels. Careful attention to allergies and drug reactions is needed as the patient cannot communicate this information. A patient interview is performed before surgery and double checked to ensure its accuracy.

The Anesthesia Patient Safety Foundation and others have made recommendations to prevent the occurrence of Medication Errors in the operating room (Table 6). High-risk drugs such as phenylephrine and epinephrine are made available in standardized concentrations using standardized diluents obtained from the pharmacy. Drugs are obtained in a ready to use form using an standardized electronic ordering and delivery system. Prefilled syringes and infusions should have standardized machine readable labels. Better standardized labeling will decrease the chance of “syringe swaps” during hectic procedures and avoid mix-ups caused by look-alike labels and look-alike medication vials. Understaffing, long, irregular hours, fatigue and haste can lead to carelessness during drug administration. (See Table 6 below)
Standardized labeling devices are available for use in the operating room if the pharmacy does not provide such labeling. These devices are programmed by the operating room caregiver to print a label containing the drug name, concentration, diluent, total amount of drug, and a bar code. Labels can be printed for syringes, IV lines, monitor lines, fluid bags, or to meet other operating room requirements as needed.

**Types of Medication Errors**

**Documentation errors**
Medical documents are generated during the chain of medical care, documenting and preserving studies performed, decisions made, diagnoses, and outcomes. Medical documents are also legal documents listing the proof of medical care. As such, they are the primary evidence used to establish the standard of care in a lawsuit.

Careful documentation can minimize the occurrence of medical errors. Basic steps include making sure the correct chart is used for documentation. The use of clear language in a legible hand, written in a concise fashion will ensure that other caregivers can properly interpret patient information. The varied background of different caregivers requires the use of standard
abbreviations in order to minimize misinterpretation and alterations in planned care.

Standardized care plans based on institutional decree or caregiver’s training can be used to structure the presentation of patient data. The SOAP and WEED formats have been commonly used, although there is now a move to institutional and specialty standards. Careful documentation requires a commitment of time. Each entry is timed and dated. Patient complaints and physical findings are objectively recorded. An overall assessment is made and the resulting plan defined. Outcomes and results of interventions are documented and assessed. Errors are deleted using a line through the entry and an initial to validate that deletion. Erasing or writing over an error has been interpreted as attempts to falsify or hide medical errors (suppression of evidence). Obtaining informed consent includes documenting that patient questions were answered and any patients concerns. Patient expectations regarding outcome need to be carefully laid out if they do not fall into the expected range of results, or there is a reasonable chance they will not be met.

Exit from the hospital includes a relevant summary of patient stay, treatment outcome, medications, and patient instructions. If the patient is not responsible, the person receiving the discharge instructions is recorded. Transfer to another facility is similarly recorded. All medical record entries are signed.

The use of electronic health records has greatly improved the availability and legibility of medical records. Patient caregiver notes, treatments and tests received, and outcomes are readily available at a hospital, or even home-based computer terminal. Electronic posting of these records facilitates caregiver communication and patient care, potentially leading to less “sick” time for the patient. Use of electronic health records may decrease the incidence of drug prescription error, adverse drug events, and medical errors. It can also ensure and document that discharge instructions are delivered to the appropriate individual or institution.

**Equipment errors**

Adverse Medical Events in the operating room can be lethal. Highly sophisticated operating rooms have been developed to detect and avoid problems unique to the operating room. Pulse oximetry is used to monitor oxygen saturation and ensure adequate oxygen delivery. Pin-indexing is used to monitor the integrity of gas cylinders and lines and ensure delivery of the expected gas to the patient. Capnography is available for monitoring...
CO₂ concentration in respired air and is useful in identifying unrecognized esophageal intubation.

The administration of gases, fluid and medications in the operating room presents the unusual risk factor related to confusion of administration route. Medical gases have reportedly been infused into the venous system and intravenous drugs have been injected into the epidural space. This Medication Error is usually related to the availability of Luer-lock adapters for different types of medical tubing.

**Patient errors**

Patients taking a medication may recognize a problem and quickly realize they have some sort of drug reaction. Some patients, however, may not recognize the association. Patient education and judgment can affect their ability to deal with the situation and avoid or minimize the occurrence of an Adverse Drug Reaction. The sensitivity of the patient to this reaction can affect their choice of reaction to it. Alternative explanation, fear of displeasing the caregiver, mental ability, and energy level all affect this decision. As many as half of patients taking prescription medications experience some sort of side effect. More educated patients and patients previously experiencing drug side effects have been reported to describe less severe side effects.

Patient age may play a factor in the development of Adverse Events as the elderly account for 34% of all written prescriptions. Elderly patients received an average of 28.5 prescriptions apiece in the US in the year 2000. Common patient errors included taking the wrong dose, taking the dose at the wrong time, missing a dose, taking ‘catch-up’ medication doses, and stopping treatment early. About 60% of elderly patients reported making at least 1 error in taking their own medications. Serious errors occurred in about a quarter of these patients. Patients that made errors were more likely to make multiple mistakes, with an average of 2.56 medication errors per patient.

Medication errors can be related to patient education. About 40% of adverse events in one study were due to unintentional overdoses. Side effects and allergic reactions were reported to occur next in frequency.

**Communication Errors**

Communication errors can occur anywhere along the patient treatment chain, from doctor to patient to nurse to pharmacist to other care giver. Patients have been reported to be more likely to express concerns, report
Adverse Events, or ask questions if their caregiver asked them questions, their caregiver was young, they were taking multiple medications, or they thought they had poor health. Caregivers usually responded to these concerns by explaining the situation, changing medications, or explaining why the side effect or Adverse Event occurred. Caregivers have been reported to ignore such concerns as much as 25% of the time.

**Missed Treatments**

Missed treatment medication errors have been best documented in the hospital. Between 1.4 and 8.4% of prescribed doses in hospitals are reported to be “missed.” Drugs with more daily doses were more likely to be “missed” and shorter acting drugs were more likely to be missed than longer acting drugs.

Seven percent of “missed” drugs in the hospital were respiratory drugs in one study. For example, 3.5% (monthly variation: 2.0 -5.0%) of all hospital bronchodilator treatments were “missed.” The most common reason for missing treatment was treatment scheduling when the patient was not present. Patient refusal and conflicting activities were also reported.

Medication diversion may result in “missed” doses and happens when a healthcare professional diverts a prescribed drug to themselves rather than the intended patient. While medication diversion occurs in hospitals, especially the diversion of drugs of abuse like opioids, it is unclear to what degree this happens. While this is a form of drug theft, it can have a greater direct negative effect on patients than simply taking drugs from a stocked supply.

Elderly patients are at high risk for missed treatment in the outpatient setting. Elderly patients take the most medications and have the most memory problems.

The consequences of one or more missed doses of a medication vary by the type of drug administered and the disease being treated. A single missed dose of an epilepsy medication can result in a seizure, for example. On the other end of the spectrum, a missed dose of a cholesterol-lowering medication has little measurable effect.

**Classification and Prevention of Medication Errors**

Decreasing the rate of medication errors requires development of a culture that promotes their identification and reporting. Close documentation of
medication errors allows analysis of their cause and the introduction of systems that can eliminate them. Classification of medication errors allow better assessment of their patient impact and help prioritize the need for intervention (Table 7). Different hospital environments will have their own unique risk factors, in addition to the common human factor.

See Table 7 Below:

<table>
<thead>
<tr>
<th>Level</th>
<th>Medical Event Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Near miss</td>
</tr>
<tr>
<td>1</td>
<td>No patient harm, no patient impact</td>
</tr>
<tr>
<td>2</td>
<td>No patient harm, required patient monitoring No patient impact detected</td>
</tr>
<tr>
<td>3</td>
<td>No patient harm, required increased patient monitoring or laboratory testing, change in vital signs noted,</td>
</tr>
<tr>
<td>4</td>
<td>No permanent patient harm, required medical treatment or increased length of hospital stay</td>
</tr>
<tr>
<td>5</td>
<td>Permanent patient disability</td>
</tr>
<tr>
<td>6</td>
<td>Patient death</td>
</tr>
</tbody>
</table>

Different techniques have been used to decrease the incidence of medication errors. Previously reported techniques include incident reports and anonymous self-reports. Failure mode and effects analysis (FMEA) was first used in the 1950’s by reliability engineers to decrease the incidence of engineering failures. It was applied in the health field in the 1990’s to minimize medication delivery errors in hospitals. The Joint Commission on Accreditation of Healthcare Organizations selected FMEA in 2001 as the basic method for improving patient safety standards. FMEA, or risk evaluation analysis, was used to identify flaws in a process, such as medication delivery, predict consequences related to the flaws, and then identify methods to eliminate or minimize the occurrence of these flaws.

The risk evaluation team draws on a wide range of expertise and includes nurses, pharmacists, physicians, and management specialists. The research team collects and categorizes failure data and determines potential consequences of each failure. The severity, likelihood, and detectability of these potential consequences and their impact on the system under study are assigned numerical values (Risk Priority Numbers). Resources are applied to address failures in order of their Risk Priority Number. FMEA analysis has been widely used in the health care delivery system for problems related to patient flow to the operation of medical equipment. Ongoing programs to monitor and decrease the incidence of medication
errors periodically revisit this problem once implemented changes have had time to stabilize, and identifies new risk factors for scrutiny.

**Conclusions**

Medical errors are traumatic to all individuals involved in health care delivery. While patient adverse effects are subject to the major outcry of public opinion, the distress to medical care workers can be significant as well. The doctors, nurses and other medical workers who commit errors these errors experience a wide range of self-imposed negative impacts including anxiety and guilt, sleeping disorders, self-doubt, and suicide. External forces can also impose upon them censure, temporary penalties, and loss of the ability to work. The installation of systems to improve medical care has greatly decreased the incidence of adverse drug reactions. Continued work is need to support and nurture the members of the caregiver team that deliver this care.
References


