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# Medication Dispensing Errors and Prevention

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## Continuing Education Activity

Close to 6,800 prescription medications and countless over-the-counter drugs are available in the United States. To further complicate a practitioner's responsibility during patient care, there are thousands of health supplements, herbs, potions, and lotions used by the public regularly to treat their health problems. With the number of substances on the market, it is conceivable that mistakes can be made when practitioners prescribe or dispense drugs. Added to this is the high risk of interaction between substances. Each year, in the United States alone, 7,000 to 9,000 people die as a result of a medication error. Additionally, hundreds of thousands of other patients experience but often do not report an adverse reaction or other medication complications. The total cost of looking after patients with medication-associated errors exceeds \$40 billion each year. In addition to the monetary cost, patients experience psychological and physical pain and suffering as a result of medication errors. Finally, a major consequence of medication errors is that it leads to decreased patient satisfaction and a growing lack of trust in the healthcare system. This activity reviews the common causes of medication errors and discusses the interprofessional team's role in taking steps to minimize medication errors.

## Objectives:

- Identify the most common errors related to medications.
- Review some of the critical points at which medication errors are most likely to occur.
- Outline some strategies to prevent medication errors from occurring.
- Summarize interprofessional team strategies for decreasing medication errors.

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## Introduction

Close to 6,800 prescription medications and countless over-the-counter drugs are available in the United States. To further complicate a practitioner's responsibility during patient care, there are thousands of health supplements, herbs, potions, and lotions used by the public regularly to treat their health problems. With the number of substances on the market, it is conceivable that mistakes can be made when practitioners prescribe or dispense drugs. Added to this is the high risk of interaction between substances.

Each year, in the United States alone, 7,000 to 9,000 people die due to a medication error. Additionally, hundreds of thousands of other patients experience but often do not report an adverse reaction or other complications related to a medication. The total cost of looking after patients with medication-associated errors exceeds \$40 billion each year, with over 7 million patients affected. In addition to the monetary cost, patients experience psychological and physical

pain and suffering as a result of medication errors. Finally, a major consequence of medication errors is that it leads to decreased patient satisfaction and a growing lack of trust in the healthcare system.[1][2]

The most common reasons for errors include failure to communicate drug orders, illegible handwriting, wrong drug selection chosen from a drop-down menu, confusion over similarly named drugs, confusion over similar packaging between products, or errors involving dosing units or weight. Medication errors may be due to human errors, but it often results from a flawed system with inadequate backup to detect mistakes.[3][4]

## Definitions

### Medication Error

While there is no uniform definition of a medication error, 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 the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing; order communication; product labeling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use." However, there is no widely accepted uniform definition. Unfortunately, untoward medical errors and underreported medication errors result in significant morbidity and mortality.[4][3][5][6]

### Adverse Drug Reaction

The World Health Organization defines an adverse drug reaction as "any response that is noxious, unintended, or undesired, which occurs at doses normally used in humans for prophylaxis, diagnosis, therapy of disease, or modification of physiological function." Adverse drug reactions are expected negative outcomes that are inherent to the pharmacologic action of the drug and not always preventable, while medication errors are preventable.[7][8][9]

### Adverse Drug Event

An adverse drug event is an injury from a medication or a missed or inappropriately dosed medication. An adverse drug event causes morbidity or mortality to a patient. The difference between an adverse drug reaction and an adverse drug event is that in an adverse drug event, the patient must be exposed to a medication with a negative consequence, which may or may not be expected. For adverse drug events, the patient suffers a negative consequence from receiving a drug in the usual manner it was intended, did not receive a medication that was required, or received the medication in a manner that was inappropriate such as too high or low a dose.[10][11][12]

### Medication Misadventure

A medication misadventure is an iatrogenic incident that is inherent to medication therapy. Medication misadventure includes medication errors, adverse drug reactions, and adverse drug events. It is created through omission or commission of medication administration. Medication misadventures always are undesirable and unexpected; they may or may not be independent of preexisting pathology; and might be due to human or system error, idiosyncratic, or immunologic response.[13][14][15]

### Sentinel Event

The Joint Commission defines a sentinel event as "an unexpected occurrence involving death or serious physical or psychological injury, or the risk thereof. Serious injury specifically includes loss of limb or function. The phrase 'or the risk thereof' includes any process variation for which a recurrence would carry a significant chance of a serious adverse outcome." Sentinel events may include medication errors, adverse drug events, and medication misadventures. Sentinel events cause significant morbidity or mortality and are possibly preventable.[16][17][18]

## Function

Medication errors can occur at many steps in patient care, from ordering the medication to the time when the patient is administered the drug. In general, medication errors usually occur at one of these points:

- Ordering/prescribing
- Documenting
- Transcribing
- Dispensing
- Administering
- Monitoring

Medication errors are most common at the ordering or prescribing stage. Typical errors include the healthcare provider writing the wrong medication, the wrong route or dose, or the wrong frequency. These ordering errors account for almost 50% of medication errors. Data show that nurses and pharmacists identify anywhere from 30% to 70% of medication-ordering errors. It is obvious that medication errors are a pervasive problem, but the problem is preventable in most cases.[19]

### Issues of Concern

Medication errors are grouped by different taxonomies by the Joint Commission, World Health Organization, and The National Coordinating Council for Medication Error Reporting and Prevention.[20][21][22]

Some taxonomies consider the source of the error:

- Deteriorated drug error from compromised storage
- Drug utilization process errors from the administration, dispensing, or monitoring
- Prescribing errors

The most common system failures include:

- Inaccurate order transcription
- Drug knowledge dissemination
- Failing to obtain allergy history
- Incomplete order checking
- Mistakes the tracking of the medication orders
- Poor professional communication
- Unavailability or inaccurate patient information

The Agency for Healthcare Research and Quality, to better standardize medication reporting, developed the Common Formats, which are defined data elements collected and reported in the event of a medication error through the Patient Safety Organization Privacy Protection Center. The scope of the Common Formats encompasses all errors, including events that those that have the potential to affect the patient, near-misses, and those that have a patient effect.[23][24][25]

Common medication error types are:

- Incorrect patient
- Incorrect medication or error of commission

### **Types of Medication Errors**

- Prescribing
- Omission
- Wrong time
- Unauthorized drug
- Improper dose
- Wrong dose prescription/wrong dose preparation
- Administration errors include the incorrect route of administration, giving the drug to the wrong patient, extra dose, or wrong rate
- Monitoring errors such as failing to take into account patient liver and renal function, failing to document allergy or potential for drug interaction
- Compliance errors such as not following protocol or rules established for dispensing and prescribing medications

### **Causes of Medication Errors**

#### **Expired Product**

Usually occurs due to improper storage of preparations resulting in deterioration or use of expired products.

#### **Incorrect Duration**

Duration errors occur when medication is received for a longer or shorter period of time than prescribed.

#### **Incorrect Preparation**

This error usually occurs with compounding or some other type of preparation before the final administration. An example is choosing the incorrect diluent to reconstitute.

#### **Incorrect Strength**

Incorrect strength may potentially occur at many points in the medication process. It usually occurs due to human error when similar bottles or syringes with the incorrect strength is selected.

#### **Incorrect Rate**

Most often occurs with medications that are given as IV push or infusions. This is particularly dangerous with many drugs and may result in significant adverse drug reactions. Examples include tachycardia due to rapid IV epinephrine or red man syndrome due to the rapid administration of vancomycin.

#### **Incorrect Timing**

In both home and institutional settings, it is challenging to be completely accurate with scheduled doses. The concern is that some medication's absorption is significantly altered if taken with or without food. As such, it is important to adhere to scheduled times as commonly; this may lead to under or overdosing.

**Incorrect Dose**

This error includes overdose, underdose, and an extra dose. An incorrect dose occurs when an inappropriate or different medication dose is given other than what was ordered, errors of omission when a scheduled dose of medication is not given, and when a drug is given via an incorrect route. Errors due to incorrect routes usually occur due to unclear labeling or tubing that is adaptive to multiple connectors/lines of access. Incorrect routes often result in result in significant morbidity and mortality.[26][27][28]

**Incorrect Dosage Form**

This occurs when a patient receives a dosage form different than prescribed, such as immediate-release instead of extended-release.

**Incorrect Patient Action**

This occurs when a patient takes a medication inappropriately. Patient education is the only way to prevent this type of error.

**Known Allergen**

Dispensing a drug that the patient has an allergy often due to failure to communicate with the patient, inappropriate chart review, inaccurate charting, or lack of technological interface.

**Known Contraindication**

This occurs when medications are not vigilantly reviewed for drug-drug, drug-disease, or drug-nutrient interactions.

**Pharmacist**

Errors by pharmacists are usually judgmental or mechanical. Judgmental errors include failure to detect drug interactions, inadequate drug utilization review, inappropriate screening, failure to counsel the patient appropriately, and inappropriate monitoring. A mechanical error is a mistake in dispensing or preparing a prescription, such as administering an incorrect drug or dose, giving improper directions, or dispensing the incorrect dose, quantity, or strength.

The most common causes involve workload, similar drug names, interruptions, lack of support staff, insufficient time to counsel patients, and illegible handwriting.

**Distractions**

One of the major causes of medication errors is distraction. Nearly 75% of medication errors have been attributed to this cause. Physicians have many duties in a hospital (e.g., examining patients, ordering laboratory and imaging studies, speaking to consultants, rounding on their patients, speaking to patient family members, conversing with insurance carriers before ordering studies), and in the midst of all this, they are often asked to write drug orders and prescriptions. In the rush to be done with writing drug orders, sometimes a lapse of judgment develops, and a medication error occurs. It can happen to the best physician. Sometimes the physician may be on the phone, and a clinician may be standing with the order chart next to him or her asking for a drug order. The physician may quickly scribble in a drug order, not paying attention to the dose or frequency. It is the unscheduled events in the life of a healthcare provider such as the constant pages, attendance at meetings, and answering telephone calls that disrupt patient care. Many physicians do not acknowledge that these distractions are a problem, but in reality, these distractions are often the cause of medication errors.[29]

To minimize distractions, hospitals have introduced measures to reduce medication errors. Most hospitals are working on ways to decrease distractions to ensure that medication orders do not occur. For example, physicians are urged to order drugs at a set time after rounding on their patients; this is when they also write their daily progress notes. Other

clinicians are requested not to disturb the physician at this time of the day. Also, clinicians are asked only to disrupt the physician for an emergency. Physicians are being urged to develop a structure for their patient care that is organized so that distractions are limited. While answering a page is often necessary, many hospitals recommend that physicians not answer patient calls until patient duties are completed. Additionally, healthcare institutions are now penalizing physicians who continue to have too many medication errors because of distractions; the result is a restriction in prescribing privileges.

Of course, not all distractions can be eliminated because the practice of medicine is itself unpredictable and chaotic at the best of times.

### **Distortions**

A prevalent cause of medication errors is distortions. The majority of distortions may originate from poor writing, misunderstood symbols, the use of abbreviations, or improper translation. A significant number of healthcare providers in the United States are from foreign countries and often write orders for medications that are not even available domestically. When a practitioner questions the drug, the physician often asks the nurse or pharmacist to substitute the medication prescribed for a similar drug. This type of distortion can lead to major errors because neither the non-prescribing practitioner nor the pharmacist can substitute a drug. All hospital pharmacies have a list of medications available in the formulary, and doctors should know what is available and limit the ordering from this list.

### **Illegible Writing**

Illegible writing has plagued both nurses and pharmacists for decades. Physicians are often in a hurry and frequently scribble down orders that are not legible; this often results in major medication mistakes. Taking shortcuts in writing drug orders is a prescription for a lawsuit. Often the practitioner or the pharmacist is not able to read the order and makes their best guess. If the drug required is a dire emergency, this also adds more risk to the patient. To eliminate such errors, most hospitals have rules that practitioners and pharmacists have to follow; if the drug order is illegible, the physician must be called and asked to rewrite the order clearly. The practitioner or the pharmacist should never guess what the drug/dose is. The bad writing by physicians has become such a major problem that the Institute of Safe Medication Practices has recommended the complete elimination of handwritten orders and prescriptions. This problem has been resolved using electronic records where everything is typed, and poor writing is no longer an issue; however, errors still can occur from writing the wrong drug, dose, or frequency.[30][31]

**Approach every prescription with caution.** There have been many new drug releases in the last decade, and generics with similar names have flooded the market. In addition to having similar names, many of these medications have multiple uses and alternative names. If the diagnosis is not stated on the prescription, there is a risk that the drug may be prescribed for too long or an inadequate amount of time. With dozens of new generics with similar names, the risk of error is very high. To counter the consequences of unintended substitutions for medications, the US Pharmacopeia has listed the names of look-alike medications, and the ISMP has developed a list of abbreviations that are routinely misinterpreted.[30]

**Write down the precise dosage.** Distortion of a dose can easily occur when nonspecific abbreviations or decimal points are used without thought. One abbreviation that is often the cause of medication errors is the "Ug" symbol for micrograms. It is often mistaken for units and should be avoided at all costs. It is best to spell out the quantity.

**Use metric measures:** The use of apothecary measures are now part of the historical archives; weight measures like grains, drams, and minims have little meaning to the modern-day healthcare workers and should no longer be used. Instead, use the universal metric measures that are preferred by pharmacists and practitioners. When using metric measures, be careful when and where you use the decimal point. For example, when writing dexamethasone 2.0 mg, if the decimal point is not visualized, the nurse or the pharmacist may think it is 20 mg. On the other hand, a zero should

always precede a decimal point. For example, when writing digoxin, it should be written as 0.25 mg and not just .25 mg. Again, if the decimal point is not seen, it can easily lead to a tenfold increase in dose.

**Consider patient age:** The two populations that are very sensitive to medications are the elderly and children. Always check the patient's age and body weight to ensure that the dose administered is correct. Also, if you write a prescription, write the patient's age and weight on it so that the pharmacist understands how you derived the dose. In children, most drugs are prescribed based on body weight.

**Liver and kidney function:** Another widespread reason for medication errors is not considering renal or liver failure. Patients with renal and liver dysfunction need lower doses. Otherwise, toxicity can result because of the failure to excrete or break down the medication.

**Provide directions:** Healthcare workers who write drug orders and prescriptions should never assume that the other party knows what you mean. Provide clear instructions on doses, the number of pills, and how and when the medication is to be taken. Writing orders like "take as directed" is a recipe for disaster. Similarly, "PRN" without an indication should never be used. It is an error in the making. Write down when the drug is to be taken and for what purpose (e.g., take 2 mg of morphine by mouth for pain. Take the morphine every 3 to 4 hours as needed for pain). Reducing medication errors requires open communication between the patient and the pharmacist.[32]

**Use of Abbreviations:** One widespread cause of medication errors is the use of abbreviations. Often the frequency of administration is abbreviated using suffixes like QD, OS, TID, QID, PR, etc. QD (meaning once a day) can easily be mistaken for QID (four times a day). Additionally, these abbreviations can have several other meanings and can be misinterpreted. It is recommended that abbreviations not be used at all when writing medication orders.[33]

**Duration of treatment:** In the past, some physicians would simply write down the total number of pills that a patient is supposed to get without specifying the duration of treatment. It is vital to specify the duration of treatment and that the duration of treatment matches the number of pills prescribed. When writing about the quantity of the drug, it is important to write down the actual number of pills (e.g., 90) rather than stating dispense for 2 months. Another reason for specifying the number of doses is that it requires the patient to comply with follow-up and prevents them from just collecting older medications. If the patient has a chronic disorder, the practitioner should be treating each flare-up as a single event with a finite number of pills. If the patient has a flare-up or exacerbation, tell him or her to come to the clinic for an exam and, at that time, determine if more pills are needed. Just empirically prescribing pills for a theoretical recurrence only leads to confusion and a high risk of adverse reactions.

**Remain alert for high-risk medications.** For example, if a patient has a deep vein thrombosis or a prosthetic heart valve and requires warfarin, only prescribe for 4 weeks at a time and reassess the patient on each visit. Do not give warfarin for many months at a time. The patient needs to be monitored for the INR, and the dose may have to be adjusted.[34]

**Always specify the indication for the drug.** Writing the indication for the drug is highly recommended because many drugs have multiple uses. Unfortunately, the majority of prescriptions never have the diagnosis written, and omitting this information increases the potential for complications. Writing the diagnosis informs the pharmacist of the diagnosis and reminds the patient of the medication's purpose. This small step can facilitate counseling by the pharmacist, reinforce the patient's treatment plan, and provide ample opportunities for patient education. It also helps improve communication between the healthcare provider and the pharmacist. For example, corticosteroids and anticonvulsants have many uses, and the pharmacist needs to know what condition is being treated.[35] An anticonvulsant may be used to treat a migraine, neuropathic pain, or behavior, besides seizures.

**Choose the appropriate drug for the patient population:** When dealing with elderly patients, healthcare providers should avoid ordering drugs listed on the Beers criteria- this list of drugs is known to have the potential to cause adverse reactions in elderly individuals.[36]

**Add supplemental instructions.** Always add extra precautions when necessary. For example, when prescribing tetracyclines, the patient should be warned about sun exposure, or when taking ibuprofen, the patient should be told to take the medication with food. When prescribing metronidazole, warn the patient about alcohol use. Do not assume that the pharmacist will add these extra warnings when dispensing the drugs. For patients who cannot read or understand the instructions for prescribed medications, educate the family, and provide verbal counseling when required.

**Adopt a reporting system.** The only way to reduce medication errors is to develop a reporting system and then make changes to prevent similar errors from reoccurring. Even a near miss should be reported. The staff should be encouraged to report without any repercussions. It is a great learning experience and enhances safety.

**Discuss the patient's preferences.** Considering the many drugs available to treat the same disorder, involve the patient in decision making. The patient should be told about the potential adverse effects and cautions.

**Write your contact number.** Many healthcare providers write prescriptions or orders in the chart and often do not leave a contact number. If there is a query about the drug, then the pharmacist and nurse are left on their own, and consequently, the patient misses out on the medication.

### **Who Is to blame: The Healthcare Professional or the System?**

In the past, when medication errors occurred, the individual who caused it was usually blamed for the mishap. Medication errors related to employees may be due to the following:

- Negligence
- Forgetful
- Hurrying
- Poor motivation
- Vengeance
- Carelessness

In such situations, disciplinary actions may include:

- Blame and shame
- Loss of privileges
- A threat of a medical malpractice lawsuit
- Relief from certain duties
- Transfer to another department

This culture of blame has shifted, and medication errors are believed to be a systemic problem. Errors in the system may be viewed as the result and not the cause. Thus, rather than focusing on changing the behavior of every healthcare worker, hospitals are now trying to understand how the system failed. This approach is designed to introduce barriers and safeguards at every level so that a mistake can be caught before the drug is given to the patient. In many cases, mistakes are made by some of the well-trained healthcare professionals, and rather than blame them; one should try and understand why the error occurred. In many cases, errors occur in recurrent patterns, irrespective of the healthcare worker involved.[37]

### **Medication Error Risk Factors**

- High volume
- Poor handwriting
- Inexperienced staff
- Challenging patient populations
- Lack of follow-up
- Lack of appropriate monitoring
- Lack of policy enforcement
- Medically complex patients
- Medications requiring calculations
- Environmental factors
- Poor communication
- Shift work
- Workplace culture
- Verbal orders
- Interpersonal factors such as external stress

### **Pharmacy Error Prevention**

Many adverse drug events are preventable, as they are often due to human error. Common causes of error related to the pharmacists include failure to:

- Deliver the correct dosage
- Identify contraindication to drug therapy.
- Identify a drug allergy.
- Monitor drugs with narrow therapeutic indexes
- Recognize drug interaction
- Recognize knowledge deficits

Often these errors can be avoided by spending time talking speaking to the patient and double-checking their understanding of the dose, drug allergies, and reviewing any other medications they may be taking. Barriers to successful communication include the inability to reach prescribers, unclear verbal and written orders and time constraints that make it challenging to check drug interactions.[38]

A pharmacist's responsibilities often include supervising patients' medication treatment and notifying the healthcare team when a discrepancy is found. Most medication discrepancies are found at discharge, highlighting the need for a pharmacist to assist in the discharge process.[39]

### **Systems-Based Drug Safety**

In the past, practitioners have borne the blame for medication errors. This has resulted in underreporting and an environment that fails to promote safety improvement. The reality is that many errors are due to poor system design

and over expectation of human performance. Improving patient safety starts with developing a cultural focus on safety improvement. The team must work together, and when an error is identified, the goal is to prevent it from happening again rather than blame the individual.[40]

## Clinical Significance

Medication errors are a common issue in healthcare and cost billions of dollars nationwide while inflicting significant morbidity and mortality. While national attention has been paid to errors in medication dispensing issues, it remains a widespread problem. The best method to enhance patient safety is to develop a multi-faceted strategy for education and prevention. Emphasis should be put on healthcare providers working as a team and communicating as well as encouraging patients to be more informed about their medications. With a culture of safety, dispensing medication errors can be reduced.

## Other Issues

### Other Strategies to Reduce Medication Errors

Over the years, hospitals have developed strategies to prevent medication errors. Some of these strategies include the following:

- Double-check the dosing and frequency of all high-alert medications. The Institute of Safe Medication Practices provides a list of high-alert medications.
- If unsure about the drug or the dose, speak to the pharmacist.
- If the writing is illegible, do not give the medication believing that you think you know what it is. Call the healthcare provider to confirm the drug or dose.
- Recheck the calculation to ensure that the patient will get the right therapeutic dose.
- Ask another clinician to recheck your calculations.[41]

### Preventing Medication Errors

- Always write one prescription for each medication.
- Besides signing the prescription, always circle your name on the preprinted prescription pad.
- Do not hesitate to check the dose and frequency if you are not sure.
- Always consider the fact that each medication has the potential for adverse reactions.
- Do not use drug abbreviations when writing orders.
- Always add the patient's age and weight to each prescription.
- Check for liver and renal function before ordering any medication.
- Spell out the frequency and route of dosage; do not use abbreviations.
- Always specify the duration of therapy; do not say give out "XXX" number of pills.
- Always be aware of high-risk medications.
- When writing a prescription, state the condition being treated.

## Enhancing Healthcare Team Outcomes

Writing prescriptions and medication orders is an everyday job duty for many healthcare workers, including nurse practitioners. However, the increased demands to see more patients who require many medications often become monotonous, and one can become careless. The majority of healthcare workers never anticipate an adverse drug event, and consequently, rarely check back with the pharmacists for drug interactions. With a high number of medication-related errors, healthcare workers are under great scrutiny to change their work habits and adopt a culture of safety when writing drug orders and prescriptions. Though there is no single way to eliminate all drug errors, healthcare workers can reduce errors by becoming more cautious and interacting closely with other practitioners, pharmacists, and patients. Open and direct communication is one way to bridge the safety gap.

An interprofessional team working together is important to achieve accurate medication utilization and decreased errors. Clinicians order medications, pharmacists, fill them, and nurses and patients administer them. Improvements in this chain of communication will ultimately provide better patient care with decreased morbidity and mortality. Better patient education on their medication offers a check and balance on the health professionals and increases safety compliance.

### Communication

When pharmacists communicate with prescribers and nurses, the pharmacist should:

- Outline the problem and then provide details
- Offer possible solutions, including substitute medications.
- Repeat back the order or order changes
- Confirm understanding
- Document conversation and decision

An environment of teamwork is most conducive to optimal medication delivery. The team should not fear discussion and resolution of conflicts. Lack of interprofessional communication limits the discovery of medication errors and uncovering their root cause. Open discussion amongst the team should be encouraged. [Level 5]

### Review Questions

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### References

1. Wittich CM, Burkle CM, Lanier WL. Medication errors: an overview for clinicians. *Mayo Clin Proc.* 2014 Aug;89(8):1116-25. [PubMed: 24981217]
2. Whittaker CF, Miklich MA, Patel RS, Fink JC. Medication Safety Principles and Practice in CKD. *Clin J Am Soc Nephrol.* 2018 Nov 07;13(11):1738-1746. [PMC free article: PMC6237057] [PubMed: 29915131]
3. Ibrahim OM, Ibrahim RM, Meslamani AZA, Mazrouei NA. Dispensing errors in community pharmacies in the United Arab Emirates: investigating incidence, types, severity, and causes. *Pharm Pract (Granada).* 2020 Oct-Dec;18(4):2111. [PMC free article: PMC7603657] [PubMed: 33149793]
4. Zirpe KG, Seta B, Gholap S, Aurangabadi K, Gurav SK, Deshmukh AM, Wankhede P, Suryawanshi P, Vasanth S, Kurian M, Philip E, Jagtap N, Pandit E. Incidence of Medication Error in Critical Care Unit of a Tertiary Care Hospital: Where Do We Stand? *Indian J Crit Care Med.* 2020 Sep;24(9):799-803. [PMC free article: PMC7584841] [PubMed: 33132563]
- 5.

- Sim MA, Ti LK, Mujumdar S, Chew STH, Penanueva DJB, Kumar BM, Ang SBL. Sustaining the Gains: A 7-Year Follow-Through of a Hospital-Wide Patient Safety Improvement Project on Hospital-Wide Adverse Event Outcomes and Patient Safety Culture. *J Patient Saf.* 2022 Jan 01;18(1):e189-e195. [PubMed: 32398537]
6. Aseeri M, Banasser G, Baduhduh O, Baksh S, Ghalibi N. Evaluation of Medication Error Incident Reports at a Tertiary Care Hospital. *Pharmacy (Basel).* 2020 Apr 19;8(2) [PMC free article: PMC7356747] [PubMed: 32325852]
  7. Neal JM, Neal EJ, Weinberg GL. American Society of Regional Anesthesia and Pain Medicine Local Anesthetic Systemic Toxicity checklist: 2020 version. *Reg Anesth Pain Med.* 2021 Jan;46(1):81-82. [PubMed: 33148630]
  8. Kefale B, Degu A, Tegegne GT. Medication-related problems and adverse drug reactions in Ethiopia: A systematic review. *Pharmacol Res Perspect.* 2020 Oct;8(5):e00641. [PMC free article: PMC7459164] [PubMed: 32869531]
  9. Gonzaga de Andrade Santos TN, Mendonça da Cruz Macieira G, Cardoso Sodré Alves BM, Onozato T, Cunha Cardoso G, Ferreira Nascimento MT, Saquete Martins-Filho PR, Pereira de Lyra D, Oliveira Filho AD. Prevalence of clinically manifested drug interactions in hospitalized patients: A systematic review and meta-analysis. *PLoS One.* 2020;15(7):e0235353. [PMC free article: PMC7329110] [PubMed: 32609783]
  10. Uhlenhopp DJ, Aguilar O, Dai D, Ghosh A, Shaw M, Mitra C. Hospital-Wide Medication Reconciliation Program: Error Identification, Cost-Effectiveness, and Detecting High-Risk Individuals on Admission. *Integr Pharm Res Pract.* 2020;9:195-203. [PMC free article: PMC7568630] [PubMed: 33117666]
  11. Mohamoud M, Horgan C, Eworuke E, Dee E, Bohn J, Shapira O, Munoz MA, Stojanovic D, Sansing-Foster V, Ajao A, La Grenade L. Complementary Use of U.S. FDA's Adverse Event Reporting System and Sentinel System to Characterize Direct Oral Anticoagulants-Associated Cutaneous Small Vessel Vasculitis. *Pharmacotherapy.* 2020 Nov;40(11):1099-1107. [PMC free article: PMC8938957] [PubMed: 33090530]
  12. Ahsanuddin S, Roy S, Nasser W, Povolotskiy R, Paskhover B. Adverse Events Associated With Botox as Reported in a Food and Drug Administration Database. *Aesthetic Plast Surg.* 2021 Jun;45(3):1201-1209. [PubMed: 33128076]
  13. Zaidi AS, Peterson GM, Bereznicki LRE, Curtain CM, Salahudeen M. Outcomes of Medication Misadventure Among People With Cognitive Impairment or Dementia: A Systematic Review and Meta-analysis. *Ann Pharmacother.* 2021 Apr;55(4):530-542. [PubMed: 32772854]
  14. Talebreza S, McPherson ML. Recognizing and Managing Polypharmacy in Advanced Illness. *Med Clin North Am.* 2020 May;104(3):405-413. [PubMed: 32312406]
  15. Bennett G, Taing MW, Hattingh HL, La Caze A. Pharmacists' perceived responsibility for patient care when there is a risk of misadventure: a qualitative study. *Int J Pharm Pract.* 2020 Dec;28(6):599-607. [PubMed: 31532031]
  16. McGowan J, Wojahn A, Nicolini JR. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Feb 6, 2023. Risk Management Event Evaluation and Responsibilities. [PubMed: 32644752]
  17. DeVine JG, Chutkan N, Gloystein D, Jackson K. An Update on Wrong-Site Spine Surgery. *Global Spine J.* 2020 Jan;10(1 Suppl):41S-44S. [PMC free article: PMC6947675] [PubMed: 31934519]
  18. Niv Y, Chorev N, Tal Y, Manor O, Broda A, Peer T, Mamadov M. [CULTURE OF SAFETY IN THE HOSPITAL]. *Harefuah.* 2019 Aug;158(8):520-522. [PubMed: 31407541]
  19. Wheeler AJ, Scahill S, Hopcroft D, Stapleton H. Reducing medication errors at transitions of care is everyone's business. *Aust Prescr.* 2018 Jun;41(3):73-77. [PMC free article: PMC6003014] [PubMed: 29922001]
  20. Chen R, Ho JC, Lin JS. Extracting medication information from unstructured public health data: a demonstration on data from population-based and tertiary-based samples. *BMC Med Res Methodol.* 2020 Oct 15;20(1):258. [PMC free article: PMC7559204] [PubMed: 33059588]
  21. Loskutova NY, Lutgen C, Smail C, Staton EW, Nichols SD, Pinckney RG. Stimulant Prescribing Error Assessment Rubric Development. *J Patient Saf.* 2022 Jan 01;18(1):e282-e289. [PubMed: 32925567]
  22. Röhsig V, Lorenzini E, Mutlaq MFP, Maestri RN, de Souza AB, Alves BM, Wendt G, Borges BG, Oliveira D. Near-miss analysis in a large hospital in southern Brazil: A 5-year retrospective study. *Int J Risk Saf Med.* 2020;31(4):247-258. [PubMed: 32568118]

23. Yount N, Zebrak KA, Famolaro T, Sorra J, Birch R. Linking Patient Safety Culture to Quality Ratings in the Nursing Home Setting. *J Appl Gerontol*. 2022 Jan;41(1):73-81. [PubMed: 33158388]
24. Radawski CA, Hammad TA, Colilla S, Coplan P, Hornbuckle K, Freeman E, Smith MY, Sobel RE, Bahri P, Arias AE, Bennett D. The utility of real-world evidence for benefit-risk assessment, communication, and evaluation of pharmaceuticals: Case studies. *Pharmacoepidemiol Drug Saf*. 2020 Dec;29(12):1532-1539. [PubMed: 33146901]
25. Luetsch K, Rowett D, Twigg MJ. A realist synthesis of pharmacist-conducted medication reviews in primary care after leaving hospital: what works for whom and why? *BMJ Qual Saf*. 2020 Oct 30;30(5):418-30. [PMC free article: PMC8070649] [PubMed: 33127835]
26. Leahy IC, Lavoie M, Zurakowski D, Baier AW, Brustowicz RM. Medication errors in a pediatric anesthesia setting: Incidence, etiologies, and error reduction strategies. *J Clin Anesth*. 2018 Sep;49:107-111. [PubMed: 29913393]
27. Hoyle JD, Crowe RP, Bentley MA, Beltran G, Fales W. Pediatric Prehospital Medication Dosing Errors: A National Survey of Paramedics. *Prehosp Emerg Care*. 2017 Mar-Apr;21(2):185-191. [PubMed: 28257249]
28. Dhawan I, Tewari A, Sehgal S, Sinha AC. Medication errors in anesthesia: unacceptable or unavoidable? *Braz J Anesthesiol*. 2017 Mar-Apr;67(2):184-192. [PubMed: 28236867]
29. Rodziewicz TL, Houseman B, Hipskind JE. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Dec 4, 2022. Medical Error Reduction and Prevention. [PubMed: 29763131]
30. Cohen MR, Smetzer JL. ISMP Medication Error Report Analysis. *Hosp Pharm*. 2017 Jun;52(6):390-393. [PMC free article: PMC5735697] [PubMed: 29276260]
31. Nuckols TK, Smith-Spangler C, Morton SC, Asch SM, Patel VM, Anderson LJ, Deichsel EL, Shekelle PG. The effectiveness of computerized order entry at reducing preventable adverse drug events and medication errors in hospital settings: a systematic review and meta-analysis. *Syst Rev*. 2014 Jun 04;3:56. [PMC free article: PMC4096499] [PubMed: 24894078]
32. Bonetti AF, Reis WC, Lombardi NF, Mendes AM, Netto HP, Rotta I, Fernandez-Llimos F, Pontarolo R. Pharmacist-led discharge medication counselling: A scoping review. *J Eval Clin Pract*. 2018 Jun;24(3):570-579. [PubMed: 29691955]
33. Samaranyake NR, Cheung DS, Lam MP, Cheung TT, Chui WC, Wong IC, Cheung BM. The effectiveness of a 'Do Not Use' list and perceptions of healthcare professionals on error-prone abbreviations. *Int J Clin Pharm*. 2014 Oct;36(5):1000-6. [PubMed: 25098946]
34. Cornuault L, Mouchel V, Phan Thi TT, Beaussier H, Bézie Y, Corny J. Identification of variables influencing pharmaceutical interventions to improve medication review efficiency. *Int J Clin Pharm*. 2018 Oct;40(5):1175-1179. [PubMed: 29860706]
35. Cheng R, Yang YD, Chan M, Patel T. Medication Incidents Involving Antiepileptic Drugs in Canadian Hospitals: A Multi-Incident Analysis. *Healthc Q*. 2017;20(2):54-62. [PubMed: 28837016]
36. Almeida TA, Reis EA, Pinto IVL, Ceccato MDGB, Silveira MR, Lima MG, Reis AMM. Factors associated with the use of potentially inappropriate medications by older adults in primary health care: An analysis comparing AGS Beers, EU(7)-PIM List, and Brazilian Consensus PIM criteria. *Res Social Adm Pharm*. 2019 Apr;15(4):370-377. [PubMed: 29934277]
37. Di Simone E, Giannetta N, Auddino F, Cicotto A, Grilli D, Di Muzio M. Medication Errors in the Emergency Department: Knowledge, Attitude, Behavior, and Training Needs of Nurses. *Indian J Crit Care Med*. 2018 May;22(5):346-352. [PMC free article: PMC5971644] [PubMed: 29910545]
38. Isaacs AN, Ch'ng K, Delhiwale N, Taylor K, Kent B, Raymond A. Hospital medication errors: a cross-sectional study. *Int J Qual Health Care*. 2021 Feb 20;33(1) [PubMed: 33064797]
39. Gillani SW, Gulam SM, Thomas D, Gebreighziabher FB, Al-Salloum J, Assadi RA, Sam KG. Role and Services of a Pharmacist in the Prevention of Medication Errors: A Systematic Review. *Curr Drug Saf*. 2021;16(3):322-328. [PubMed: 33006539]
- 40.

Avery AJ, Sheehan C, Bell B, Armstrong S, Ashcroft DM, Boyd MJ, Chuter A, Cooper A, Donnelly A, Edwards A, Evans HP, Hellard S, Lymn J, Mehta R, Rodgers S, Sheikh A, Smith P, Williams H, Campbell SM, Carson-Stevens A. Incidence, nature and causes of avoidable significant harm in primary care in England: retrospective case note review. *BMJ Qual Saf.* 2021 Dec;30(12):961-976. [PMC free article: PMC8606464] [PubMed: 33172907]

41. Lenz JR, Degnan DD, Hertig JB, Stevenson JG. A Review of Best Practices for Intravenous Push Medication Administration. *J Infus Nurs.* 2017 Nov/Dec;40(6):354-358. [PubMed: 29112582]

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