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Preventing Medication Errors with Medication Reconciliation

REVIEW ARTICLE

Cover letter

May 28, 2020
Editorial Department

Dear Editor ,

I am submitting a manuscript for consideration of publication in the Journal . The manuscript is entitled “Preventing medication errors with medication reconciliation: A review article”.

It has not been published elsewhere and that it has not been submitted simultaneously for publication elsewhere.

Medication errors are the leading cause of morbidity and mortality in the world. pharmacist-led medication reconciliation at admission time and at times of transition between care settings in addition to the use of information technology systems can help in reducing and preventing medication errors. We believe that this manuscript is appropriate for publication . Our manuscript creates a paradigm for future studies of Preventing medication errors with medication reconciliation.

Thank you very much for your consideration.

Yours Sincerely,

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Preventing medication errors with medication reconciliation: A review article

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Abstract

The use of medications is omnipresent. Errors can happen at any point in the medication-use process and in any care setting. Medication errors are the leading cause of morbidity and mortality in developing countries as in the developed ones. Designing and maintaining accurate medication reconciliation process is a key approach for reducing medication errors. In this review, we summarize the important role of pharmacist-led medication reconciliation at admission time and at times of transition between care settings in preventing medication errors and adverse events. Lastly, we present successful examples of the use of information technology systems in reducing and preventing medication errors.

Key words:

Medication reconciliation. Medications errors. Information technology

Introduction

Medication errors are the leading cause of morbidity and mortality in the medical field. Medication errors ranked in the third position of causes of death in the United States, after heart disease and cancer (Makary, Daniel, 2016) see figure 1

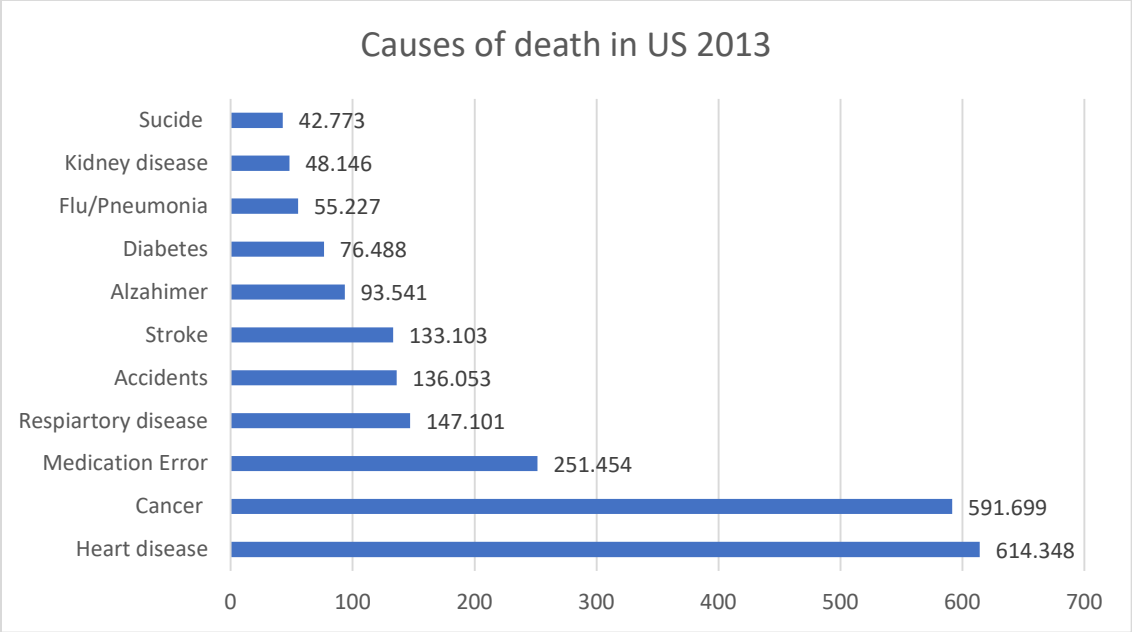

Figure 1: Causes of death, US, 2013

Medication errors affect one million and more patients in the United States annually and may lead to the death of some of them (WHO, 2007). More than 67% of prescriptions are evaluated, one or more error was observed at different time during patient care, with the spread of errors in hospitals (WHO, 2007).

In 1995, the United States Pharmacopoeia (USP) held its first meeting with 15 interdisciplinary organizations with the authority, mechanisms and resources to find solutions to the problems of medication errors that negatively affect the healthcare and safety of patients (NCCMERP, 2015a). The National Coordinating Council for Medication Errors Reporting and Preventing (NCC MERP / The Council) has been formed to encourage reporting, understanding and

prevention of medication errors to improve patient safety via the participation of these organizations using a systems-based perspective (NCCMERP, 2015a).

Reason's theory of the Human Error has been widely accepted as a framework for the system-based patient, raising awareness about importance of continuous improvements and preventing errors that affect patient safety. The problem of human error can be seen from two views: the person approach and the system approach (ASHP, 2018). Because human beings are not perfect, mistakes should be expected. Blaming or passive encourage healthcare workers to be more careful will not prevent these errors because it does not change the latent conditions that contributed to the error. A system based approach seeks to change the conditions of the worker and to build defenses, barriers and safeguards to prevent errors in the future; or mitigate risk to decrease negative effects of mistakes (ASHP, 2018).

Reason (2000) depicted that through the Swiss cheese symbolic model. The defensive lines in Fig. 2 are supposed to be intact, but in fact they look like Swiss cheese slices, the layers are full of holes. Having holes in any one "slice" does not necessarily mean a negative outcome but when the holes (as a result of errors and near misses occur) are lined up in many layers in a path that increases the opportunity of accidents - causing damage to the victims (Reason, 2000). The holes in the defenses due to two reasons: active failures and underlying (latent) conditions. All adverse events involve mix up of these two groups of causes (Reason, 2000).

Active failures are the unsafe practices of healthcare providers towards the patient or the system and they directly and short-term affect the safety of the defenses and cannot be predicted specifically (Reason, 2000). The underlying (latent) conditions are "resident pathogens" that cannot be avoided in the system. These are strategic decisions capable of creating system gaps and may remain hidden within the system for years before they combine with their active failures to create opportunities for accidents. Underlying situations can be identified and corrected before an adverse event happen. This leads to proactive risk management rather than reactive risk management. Examples include: time pressure, staff shortness, inadequate equipment, fatigue, lack of training, unreliable alarm systems, a design and construction deficiencies (Reason, 2000).

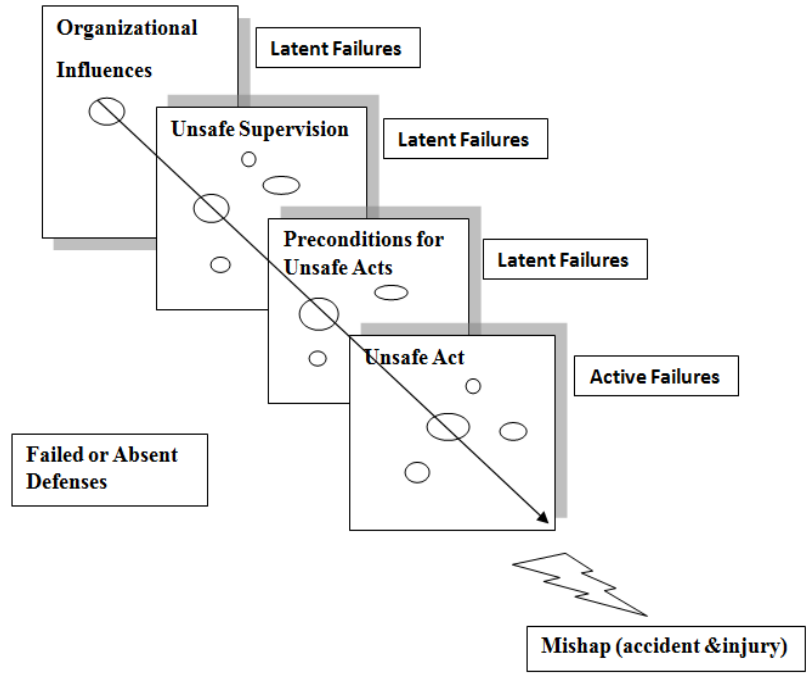

Figure 2:Reason's swiss cheese model

Definition of a medication error

There is no agreement about the definition of a medication error. A systematic review of literature found twenty-six different terminologies used for a medication error are not the same(Lisby *et al.,* 2010).A medication error can be defined as any error that may occur during the process of medication use (Williams, 2007).The most comprehensive definition for a medication error is put by the United States National Coordinating Council for Medication Error Reporting and Prevention as the following:"Any preventable event that may cause or result in inappropriate medication use or harm to the patient during the control of the medicine by a healthcare professional, patient or consumer." These 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" (NCCMERP, 2015b). The frequency of errors was estimated to be at the prescribing stage 39%, at the transcribing stage 12%, at the dispensing stage 11%, And during administering stage 38%. However, most of the

errors that actually affect the patient in the hospital occur at administration stage when the dose of the medication is given incorrectly at bedside (Leape *et al.*,1995).

Figure 3: Errors in medication use process

Example in case scenario and figure 4 for a fatal case of medication error due to methotrexate overdose with the Reason's Swiss Cheese Model

Case scenario :an example (Shaikh *et al.*,2018) edited by us

A 78 years old female patient was admitted to a hospital due to deep venous thrombosis (DVT).According to referral history,the patient with severe rheumatoid arthritis (RA) and use methotrexate 7.5 mg (low dose therapy) weekly (on Friday).However, the dose was transcribed in the patient's medication list to 7.5 mg daily(on afternon).After six days of hospital admission,the patient experience a worsening of symptoms.This finding lead checking the patient's medication list after 10 days of hospitalization.The doctors discoved that methotrexate was administered to patient accidental daily rather than weekly dosing.The patient died with sepsis after two weeks of hospital stay

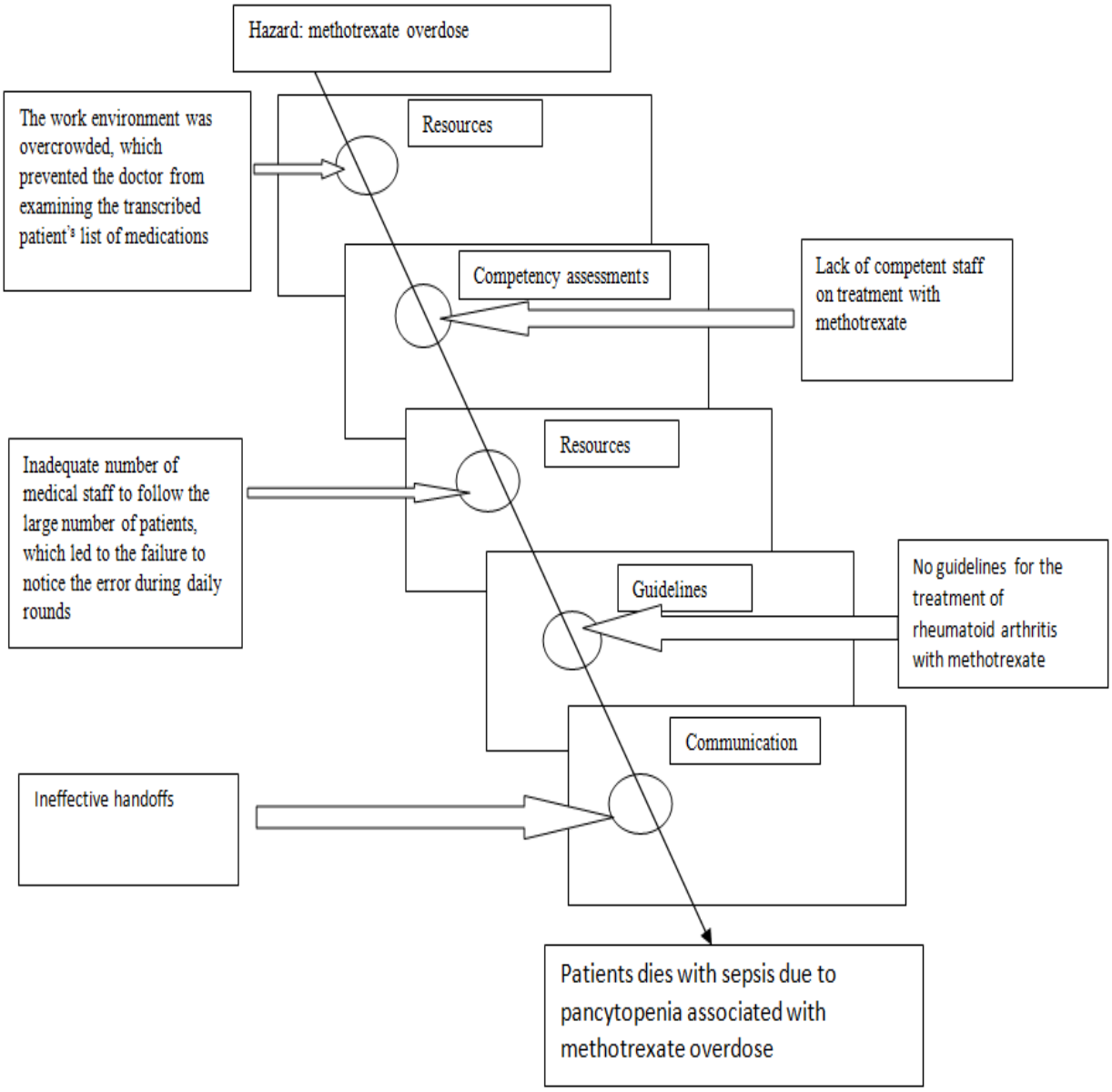

Figure 4: A fatal case of medication error due to methotrexate overdose with the Reason's Swiss Cheese Model

Medication errors classification, types and categories

Table 1: The classification of medication errors based on a psychological approach (Ferner, Aronson, 2006; Aronson, 2009)

Type of error	Example	Outcome
Knowledge based	To be unaware of drug interaction between warfarin and Macrolides (ex: erythromycin and clarithromycin)	Increase risk of bleeding
Rule based	-Prescribing of oral therapy in a patient with dysphagia -Using overdose of a medicine	Lung aspiration or failure to cure
Action based (slips)	Being distracted, writing diazepam for diltiazem	Sedation
Technical	-The handwriting is unclear, leading to confusion so that the "Panadol" (paracetamol) is dispensed instead of "Priadel" (lithium)[a] -Failure associated with cannula insertion	Loss of effect
Memory based (lapses)	Forget determine the maximum daily dose of the drug "as required"	unnecessary treatment or toxicity

a This emphasizes the importance of using the generic name whenever possible because more errors occurred by brand names confusion than generic names.

Table 2: Medication error types and examples (Misasi, Keebler, 2019).

Error type	Example
Wrong dose(regardless of appropriateness)	Intended 75 mg diclofenac sodium, administered 100 mg diclofenac sodium
Inappropriate or jeopardize situation for administration/ not indicated	Administration of Amiodarone (an antiarrhythmic drug) to cardiac arrest patient with PEA[a]
No guidelines / unauthorized (regardless of appropriateness)	Appropriate administration of drug, without guideline or online authorization
Wrong drug	Intended chlorpropramide, administered chlorpromazine
Dilution/ preparation error (correct dosage)	potassium chloride was given to the patient without dilution with a compatible I.V. solution(fatal)
Omission of medication	A single dose of prophylactic antibiotic not given prior to incision that increased incidence of postoperative SSIs[b]
Wrong route of administration (correct dose)	intramuscular versus intramuscular and vice versa
Contraindicated	Use of Isotretinoin (a drug used for acne) in pregnant
Expired medication	Use a Medicine beyond the labeled expiration date
Wrong time/ late medication administration	Prophylactic Antibiotics was not given within 30 to 60 minutes of a surgical incision

[a] PEA :pulseless electrical activity

b SSIs :Surgical site infections

Table 3. Medication error reporting and prevention index category definitions (Misasi, Keebler, 2019)

Category	Definition
Errors that do not 'reach' the patient/ incomplete errors	
No error	
Category A	Circumstances or events that have the capacity to cause error (i.e. a safety concern).
Error, no harm	
Category B	An error occurred but the error did not reach the patient, an 'error of omission' does reach the patient (i.e. a near-miss).
Errors that 'reach' the patient/ Completed errors	
Error, no harm	
Category C	An error occurred that reached the patient, but did not cause patient harm.
Category D	An error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to the patient and/or required intervention to preclude harm.
Error, harm	
Category E	An error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention.
Category F	An error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization.
Category G	An error occurred that may have contributed to or resulted in permanent patient harm.
Category H	An error that occurred that required

	intervention to sustain life.
Error, death	
Category I	An error that occurred that may have contributed to or resulted in the patient's death.

Causes of medication errors

Table 4: Factors that may influence medication errors (Avery *et al.,* 2012**;** Slight *et al.,*2013)

Factors related to health care providers ➢ Inadequate therapeutic training ➢ Insufficient drug knowledge and skills ➢ Inadequate patient education ➢ Insufficient perception of risks ➢ Overloaded or fatigued health care providers ➢ Physical and emotional health problems (ex: sadness, depression) ➢ Lack of communication between health care providers and with patients
Factors related to patients ➢ Characteristics of the patient (e.g., language barriers) ➢ Clinical cases complexity, including multiple health problems, concurrent use of multiple medicines by the patient (polypharmacy) and high-alert medications
Factors related to work environments ➢ Overload and time pressures ➢ Interruptions and distractions in workflow so the duration of healthcare providers' tasks (scheduled and non-scheduled) increases as they have to manage many interventions simultaneously. ➢ Lack of standardized essential guideline and policy & procedures ➢ Inadequate Resources (e.g., human, financial) ➢ Physical work environment (e.g., lighting, ventilation and temperature)
Factors related to medicines ➢ Confusion associated with look-alike &sound alike medications (LASA). ➢ Labeling mistakes
Factors related to tasks

➢ Repetitive systems for ordering, processing and authorization ➢ Patient monitoring (dependent on practice, patient, other health care settings, prescriber)
Factors associated with computerized information systems ➢ Technical problems of system and System incompatibility with workflows in manual system ➢ Difficulty of access to information and inaccuracy of patient records. ➢ Inadequate design that allows for human error
Primary-secondary care interface ➢ Ineffective communication with secondary care in the absence of structured transfer protocols ➢ Insufficient justification of secondary care recommendations

Relation between medication errors, adverse drug events and adverse drug reactions

A medication error is defined as "any error (commission or omission) that may occur at any stage along the pathway that starts from the physician writing a prescription and ends when the patient actually receives the medicine". ADE is defined as "any injury occurring during medication treatment of the patient resulting from either appropriate, inappropriate or substandard care". (CoE, 2005) The definition therefore includes ADRs and MEs. However, ADE does not necessarily mean that there is an error or a poor quality of care (AHRQ, 2019a).

In 2015, the NCCMERP proposed that the term "ADE" should be divided into two categories, the first "preventable" and the other "non-preventable", and the cessation of the use of the term "ADR". (NCCMERP, 2015a)

"Preventable ADE" is any degree of harm caused by a medication error that reach the patient and can be prevented. It represents 25% of ADEs (IOM, 2006). (For example, giving the patient a normal dose of the drug but the medicine is contraindicated in this patient). These events should be investigated by the healthcare provider to determine why it occurred. (NCCMERP, 2015a)

"Non-preventable ADE" is a medicine-induced harm, although the medicine is used properly (for example, anaphylaxis in the patient from the use of antibiotic and the patient has no previous allergic reaction history) (NCCMERP, 2015a). These situations (which are popularly known as

side effects) cannot be prevented at the present time. The uniform use of these terms will focus on elimination of preventable ADE. The algorithm (see Figure 5) is distinguished between "preventable ADEs" and "non-preventable ADEs". (NCCMERP, 2015a), (AHRQ, 2019a)

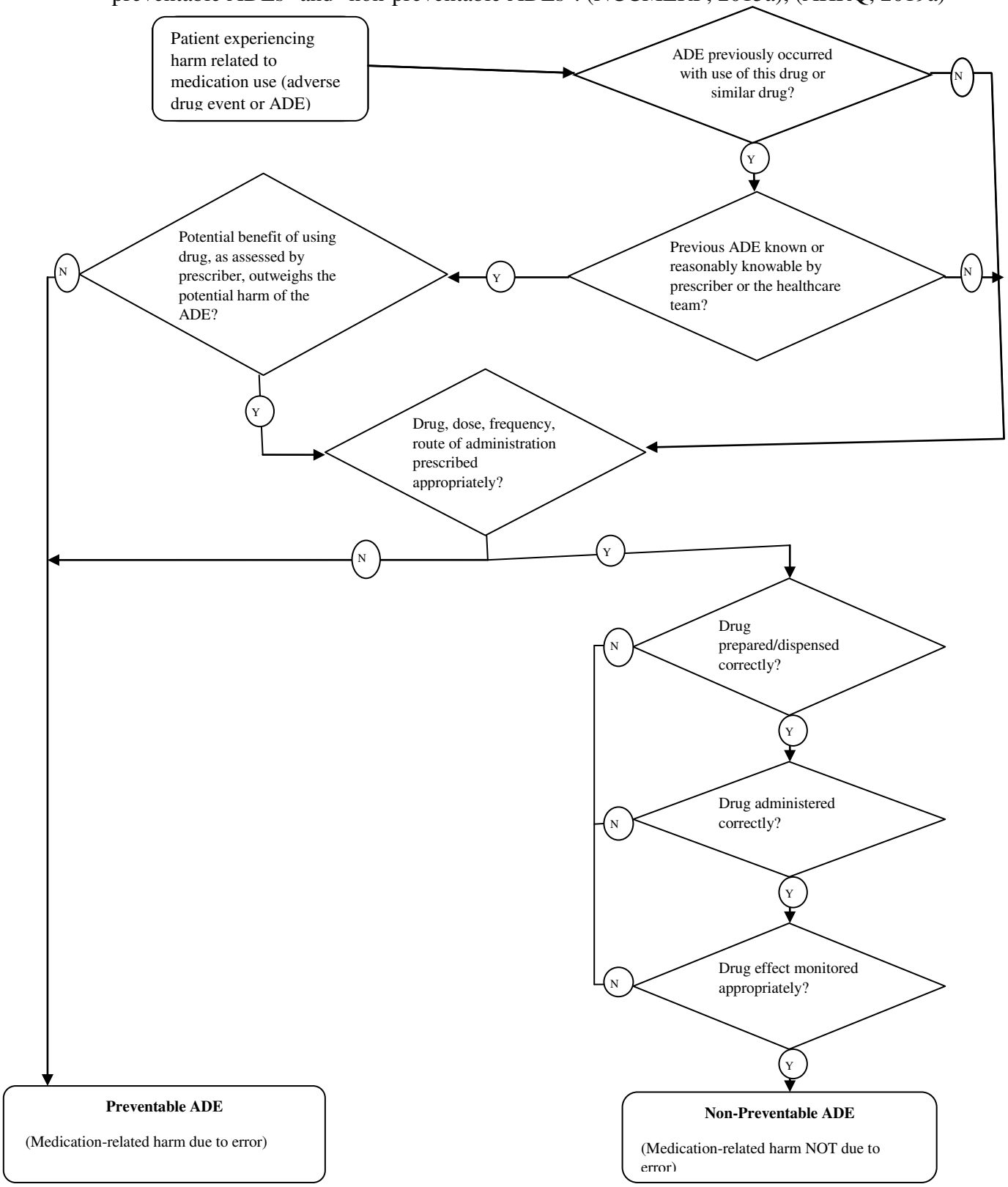

Figure 5: The algorithm distinguishes between "Preventable ADEs" and "Non-Preventable ADEs (NCCMERP, 2015a)

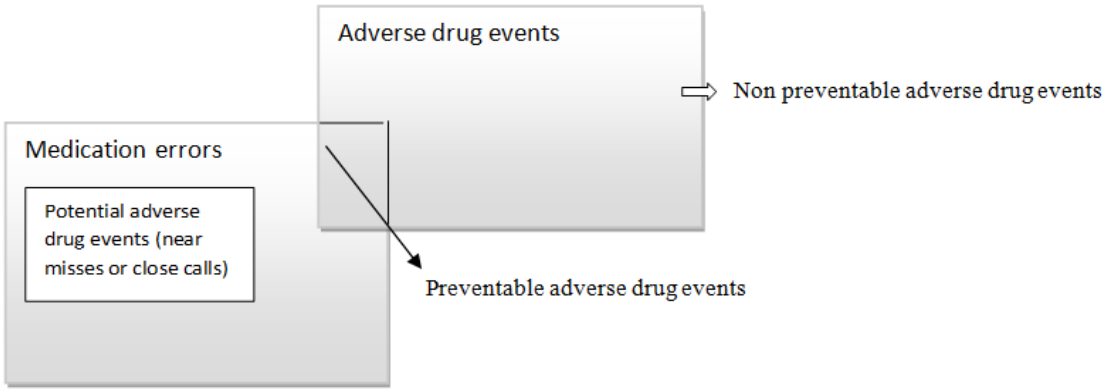

Figure 6: Relation between medication errors, adverse drug events and adverse drug reactions

Medication errors that do not actually result in patient harm - either because they are discovered before they reach the patient or because of chance (luck) - are called potential ADEs or near misses or close calls (AHRQ, 2019a).

A medication error either leads to harm to the patient or has the potential to lead to, cause harm to the patient "(Aronson, 2009) this is in contrast to the adverse drug event (ADE), which is" an unintended actual drug event that occurs during medication treatment. "The difference lies in the occurrence of the event in the ADE however, the medication error is a failure in the treatment process may result in the event. An example of a medication error is when a patient is not prescribed with his/her regular medications upon admission to the hospital; this will be omission error. However, When the right dose of a medicine is given to the patient and leads to unintended side effects ex: anaphylaxis, it will be classified as adverse drug event (ADE) (Bates *et al.,*1995; Knez *et al.,* 2011). Medication reconciliation play a vital role in improving patient safety by reducing medication errors at discharge and during transition of care and shifts in care (Karapinar-Carkit *et al.,* 2009).

Table5. Strategies to Prevent Adverse Drug Events and medication errors (AHRQ, 2019a)

Stage	Safety Strategy
Prescribing	➢ Avoid unnecessary medications by following the principles of conservative prescribing ➢ Use of computerized physician order entry with clinical decision support (CPOE-CDS) ➢ Medication reconciliation at times of transitions in care
Transcribing	➢ Use of computerized physician order entry (CPOE)to eliminate errors related to ambiguity of handwriting
Dispensing	➢ Inpatient pharmacists to oversee dispensing process ➢ Proactively Implement safety strategies to minimize confusion between look-alike, sound-alike medications (LASA medications) ex: Use of "tall man" lettering ➢ Use of Automated dispensing cabinets for high-alert medications.
Administration	➢ Follow the "Five Rights" of medication administration (administering the Right drug, in the Right Dose, at the Right Time, by the Right Route, to the Right Patient) ➢ Implementation of Barcode medication administration (BCMA)technology to ensure medication is given to the correct patient ➢ Reduce interruptions to allow nurses to administer medications safely ➢ Use of Smart infusion pumps for intravenous infusions

	➢ Use of electronic Multicompartment medication devices and reminder systems for patients taking multiple medications in ambulatory or long-term care settings ➢ Educate patients about their medications

Medication errors related to high alert medications

According to the Joint Commission, based on the work of Institute For Safe Medication Practices (ISMP), high-alert medications are defined as "medications capable of causing significant patient harm when they are used in error (IHI, 2012).

Errors of these medications may not be as common as we think, but if they reach the patient, their consequences are fatal. ISMP began its activities in 1989 with the publication of the first list of "high alert" medications (Davis, Cohen, 1989).

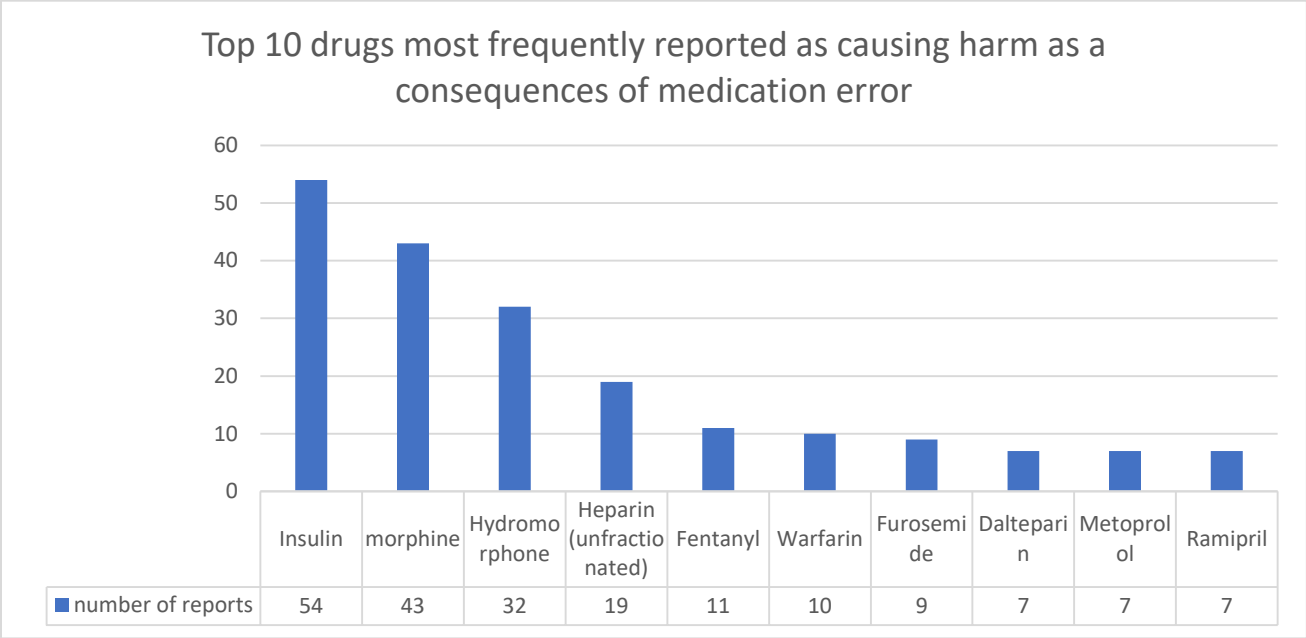

Figure 7. Top 10 drugs most frequently reported as causing harm as a consequence of medication error (ISMP, 2006)

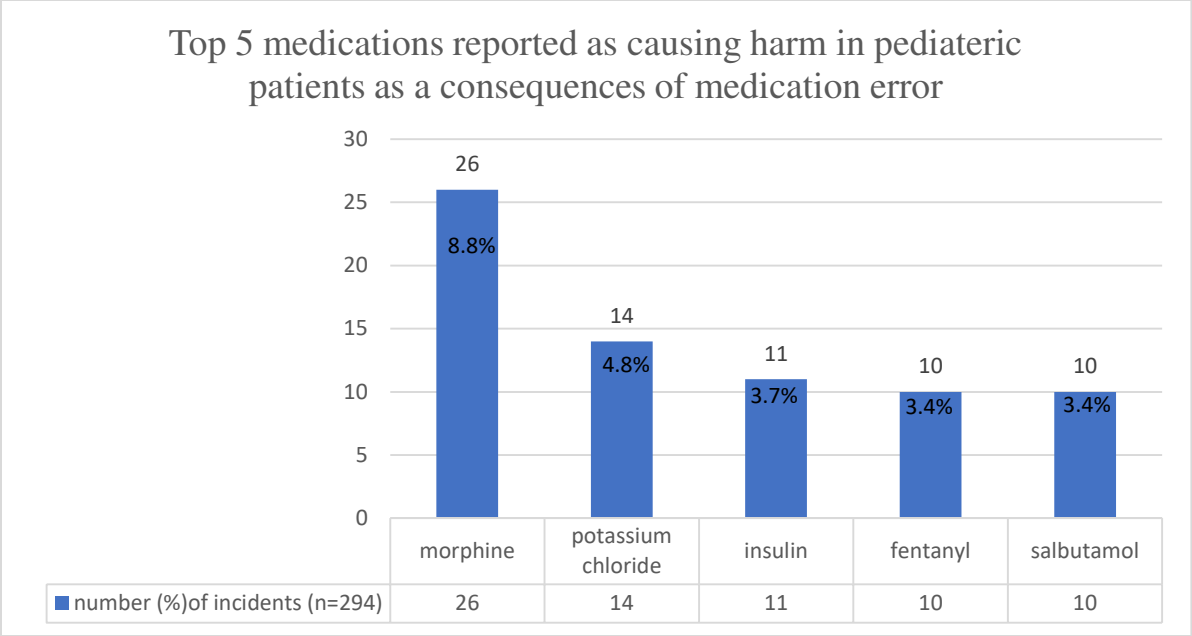

Figure 8: Top 5 Medications Reported as Causing Harm in Pediatric Patients as a Consequence of Medication Error (Based on Reports from 11 CAPHC Member Organizations) (ISMP, 2009)

A review of 317 preventable adverse drug events in adverse drug events database. Reveal important findings that three high priority preventable ADEs represented 50% of all reports: (1) Haemorrhagic events associated with overdoses of anticoagulants due to inappropriate dosage adjustment according to laboratory test results (2) somnolence (drowsiness) and respiratory depression (hypoventilation) associated with overdoses of opiate agonists due to insufficient medication appropriateness (3) hypoglycemia associated with overdoses of insulin due to insufficient monitoring of insulin (Winterstein *et al.,*2002;Anderson, Townsend,2015).

Therefore, Hospitals have been working to improve the safety of high alert medications by maintaining a comprehensive list of identified high-alert medications to address potentially harmful errors based on ISMP updates for high-alert medications (www.ismp.org/Tools/institutionalhighAlert.asp). Also, Other medicines can be added to the list Such as new medicines which is considered to be high risk is added to the hospital formulary, all medicines regarded as potentially harmful used temporarily in cases of emergency and shortage and can be removed once the situation is over, and by hospitals in their internal event reporting systems for medicines involved in potential adverse events, even if the medicine is not included in ISMP list. For example, wrong route of administration errors if Exparel (bupivacaine liposome

injectable suspension) is confused with propofol, due to similarity in appearance and accidental intravenous administered instead of propofol, ventricular arrhythmia and cardiac arrest might result, hospitals added the drug to their list. The hospital pharmacy and therapeutics committee should update the list of high-alert medications as needed and should review it at least every two years (Grissinger,2016).

ISMP recommends conducting a multi-disciplinary failure mode and effects analysis (FMEA) as a proactive risk assessment tool to systematically identify sources of failure with the use of high alert medications in addition to the importance of using medication reconciliation to improve handoffs of drug information (IHI, 2012).

Medication reconciliation is a useful strategy to prevent medication errors

Drug reconciliation (see Figure 9) is the process of comparing the patient's list of current medication to all medications was taken by the patient and patient's condition to avoid any discrepancies. Medication reconciliation is a process designed to reduce medication errors such as omission, medication dosing errors, therapeutic duplication, or drug interactions. This should be done at every transition of care in which new medicines are requested or the current orders are rewritten (The Joint Commission, 2006).

Transitions in care involve changes in healthcare practitioners, setting or care level. This process consists of five steps: (1) current medications list; (ii) a list of prescribed medications; (iii) a comparison of two lists; (iv) clinical decision according to the comparison; (v) communicate the new list to health care providers and to patients (The Joint Commission, 2006)

Preventable adverse drug events (ADE) at transition of care represent 46-56% of all medication errors (Chhabra *et al.,* 2012).

In 2005medication reconciliation was designated as international patient safety goal # 8 by the Joint Commission (AHRQ,2019b). In 2011, medication reconciliation was integrated into international Patient Safety Goal #3, "Improving the safety of using medications." This National Patient Safety Goal requires that organizations "maintain and communicate accurate medication information" and "compare the medication information the patient brought to the hospital with

the medications ordered for the patient by the hospital in order to identify and resolve discrepancies." (AHRQ, 2019b)

Obtaining a best possible medication history (BPMH) for the patient at the time of admission to hospital is an essential part of medication reconciliation because the medication history is generally helpful in determining the medication regimen during hospitalization, so any inconsistency in medication history may lead to a discrepancy during hospitalization period(Mazhar *et al.,*2017). 22% of drug discrepancies can lead to patient harm during hospitalization, while 59% of them stay after discharge (Boockvar *et al.,* 2011).

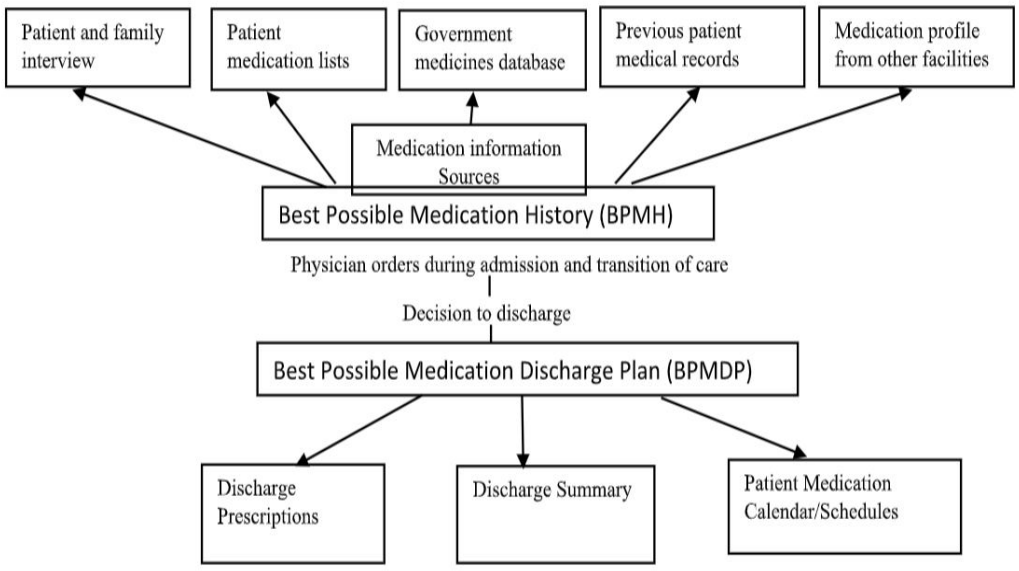

Figure 9: overview of Medication reconciliation process

Table 6: Types of medication discrepancies at the time of hospital admission (Boockvar *et al.,* 2011; Hellstrom *et al.,* 2012; Mazhar *et al.,*2017).

Intended medication discrepancies • Drug initiation or dosage modification is according to the new clinical condition of the patient • Medical decision not to prescribe a medicine or to change its dose, frequency or route of administration • Formulary/therapeutic substitution based on hospital policy
Unintended medication discrepancies • Omission of a regularly used medication or prescribed medication (accounts for 42%-60% of medication errors) • Differences in dose, frequency, time and route of administration • Wrong medicine • Medicine use without indication • Therapeutic duplication • Drug interaction

Table 7: Examples of Drug Related Problems Identified and interventions.

Identified Problem	**Intervention**
The patient took atorvastatin 40 mg (a cholesterol –lowering medication) before admission. There was no atorvastatin or other drug in the same class (statins) for replacement.	The doctor has been notified of the omission and the medicines included
The patient, who suffers from diabetic neuropathy, has been on treatment for two years. Medicines are not prescribed to treat these diseases upon admission.	The doctor has been notified of the omission and the medicines included

The patient is using enalapril 25 mg (ACE inhibitor) [a] to treat hypertension once daily before entering the hospital. The dose was doubled by admission, although there was no history of high blood pressure or any other medical condition that could lead to dose adjustment.	The doctor has been notified and the dose adjusted.
Identifying patient at high risk for venous thromboembolism however, the prophylaxis drug was not prescribed.	The doctor has been notified of the omission and the medicines included

[a]ACE:angiotensin converting enzyme

Conclusion

Although medication errors cannot always be prevented, but organizations can minimize potential harm by implementing medication reconciliation process at hospital admission or care transfers, pharmacists in the health system are responsible for conducting drug reviews to improve current system. medication reconciliation is also important in improving safety of high alert medications. Furthermore, the importance of adopting information technology systems in reducing and preventing medication errors such as Computerized Physician Order Entry(CPOE), Clinical Decision Support System (CDSS), Barcode Medication Administration (BCMA), electronic medication reconciliation, automated dispensing and secure platforms to share patient data across healthcare providers and patients.

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