Medication Errors

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***Abstract*—In this review article we will know about how medication error affects the patient's health by knowing its adverse drug reaction, adverse drug event, disadvantages and some other types of medication errors, strategies, prevention, control measures. Medication errors are a significant a public health concerns that can lead to serious patient harms, increased healthcare costs, and reduced trusts in the healthcare system. These errors can occur at any stage of the medication use process- including prescribing, transcribing, dispensing and administrating and monitoring- and may results from human mistakes, system failures, communication gaps, or lack of proper training. Common type of medication errors include incorrect drug selection, dosage miscalculations, wrong route or timing of administration, and confusion between look-alike or sound-alike (LASA) drugs.**

Factors contributing to medication errors including poor handwriting, ambiguous drug names, inadequate knowledge of drug interactions and failure to follow established protocols. High risk environment such as emergency department and intensive care units are particularly vulnerable due to their fast-paced, and High stress nature. Errors can lead to adverse dug events (ADEs), prolonged hospital stays, increase morbidity and mortality, and legal implications for healthcare provider. The prevention of medication errors are requires a multifaceted approach involving healthcare professionals, patients and healthcare systems.

Strategies include implementing electronic prescribing system (e-prescribing) barcode medication administration (BCMA) and computerized physician order entry (CPOE) systems. Standardizing procedures, promoting a culture of safety, improving communication among healthcare teams, and providing continuous education and training are also vital.

Reporting system for medication errors should be encourage without fear of punishment to identify root causes and implement corrective actions. Patient involvement in their own care, such as understanding their medication regimens and asking questions and also plays a critical role in minimizing errors.

***Index Terms*—Medication Error, Patient safety, Health, Prescription, LASA, ADR, Prevention, Strategies.**

I. INTRODUCTION

Medication error is "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of a health professionals , patient or consumer", defined as per World Health Organization (WHO) .

Medication errors can arise from various factors, including weak system, human factors and environmental conditions, emphasizing the complexity of the issue. The definition emphasizes the potential for both inappropriate medication use and actual harm to the patient. Medication errors are caused by incorporating wrong an inaccurate doses in the product development which cause discomfort leading to severe problems for patients .

According to World Health Organization (WHO) medication errors result in thousands of injuries and deaths annually, leading to increase in health care cost and reduced trust in medical care. The complexity of modern pharmacotherapy , combined with high workload of health.

This research paper aims to explore the causes, types, consequences, and prevention strategies of medication errors. By analysing current data and existing literature, the study seeks to emphasize the importance of implementing effective safety measures, education, and technological interventions to minimize the medication errors and enhance patient care quality.

ADVERSE DRUG REACTIONS

An adverse drug reaction is an unintended and harmful response to a medication taken at a normal dose and as instructed. ADR can occur after a single dose, prolonged use or combining multiple drugs. This reaction can range from mild to severe and may be caused by various factors.

ADVERSE DRUG EVENT

Adverse drug events are defined as any injuries resulting form medication use, including physical harm, mental harm or loss of function. ADEs compared with medication error, are a more direct measure of patient harm.

TYPES OF MEDICATION ERRORS

There are the types of medication errors as per ASHP

- Prescribing error
- Dispensing error
- Omission errors
- Wrong time error
- Unauthorized drug errors
- Improper dose errors
- Wrong dosage form error
- Wrong drug preparation errors
- Wrong drug administration errors
- Monitoring errors
- Compliance errors
- Other medication errors

1. Prescribing error:- Prescription error is prescribing unintentionally / by mistake incorrect or incomplete dosage form, drug names , medicines , Brand names of medication, improper instructions about medication by prescriber / physician.

Example:-

- Illegible or confusing handwriting of doctor
- Incorrect route of administration is received by patient (Patient wants tab oliment bus received injection oliment)
- Incorrect frequency and duration of medicine (Patient's correct dose is 3 times in a day but in prescription it is 4 times a day)

2. Dispensing error:- Dispensing error is dispensing incorrect improper dosage form, drug , medicine , route of administration of medicines (LASA drugs) unintentionally by pharmacist to the nurse or patient in hospital/pharmacy.
3. Omission error :- This is a type of error when the medication are not administer on given schedule time by patient.
4. Wrong time error :- Wrong time error is to scheduling conflicts or timings mismatches due to miscommunication , scheduling mistakes or time zone differences.
5. Unauthorized drug errors :- It take place when patient receives a medication without the prescribers proper consent.
6. Improper dose error :- Improper dose error refers to the administration of a medication or treatment in a dose that is incorrect either too high or too low , which can be lead to adverse effects , reduced efficacy of the medicines or harm to the health of the patients.
7. Wrong dosage form error :- Wrong dosage form error can be occurs when a medication error is administered to patient in different pharmaceutical dosage form than intended ,such a s a tablet instead of capsule, or an injectable instead of oral formulations.
8. Wrong drug preparation errors :- Wrong drug preparation errors take place when medication not prepared correctly before administration, which includes incorrect mixing of drug or reconstitution, wrong solvent or vehicle is used for the preparation and contamination of drugs during preparation. This can lead to adverse reaction and reduced efficacy of the medicines.
9. Wrong drug administration errors :- Wrong drug administration errors occurs when medication is given to patient incorrectly such as wrong medication administrated, wrong dose administered ,wrong route of administration (e.g.. IV instead of oral) ,wrong patient received the medication. This can lead to adverse reaction, harm to the patient's health and even life-threatening consequences.
10. Monitoring error :- Monitoring error is takes place when there is a failure to adequately observe, track or responds to patient's condition, treatment or medication effects. This includes inadequate vital sign monitoring , failure to recognize adverse reaction, insufficient lab testing monitoring , delayed or incorrect response to changes in patients condition. This may lead to delayed

intervention, worsening of the condition ,or harm to patient.

11. Compliance errors:- It is occurs when failure to follow established medication protocols , guidelines or regulation, which includes ignoring medication safety procedures , failure to document medication accurately, not adhering to medication administration policies ,nit following dosage and administration instructions.
12. Other medication error

II. THE CONSEQUENCES OF MEDICATION ERRORS

A medication error can lead to numerous complications, including long-term injuries or fatalities.

The following categories were described errors,

- Augmented (dose-related) :- an abnormal pharmacodynamics response to a drug, for example, sensitivity to an opioid drug resulting in respiratory depression.
- Bizarre (non-dose-related) :- anaphylactic or anaphylactoid reactions.
- Chronic (dose-related and time- related) :- due to prolonged exposure to a drug, for example, renal failure secondary to methoxyflurane.
- Delayed (time-related) :- teratogenesis seen with thalidomide.
- End of use (withdrawal) :- suppression of the hypothalamic-pituitary-adrenal axis after prolonged steroid therapy.
- Failure (unexpected failure of a therapy) :- awareness under general anaesthesia.

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IV. Delayed (time-related)- teratogenesis seen with thalidomide.

V. End of use (withdrawal)- suppression of the hypothalamic -pituitary-adrenal axis after prolonged steroid therapy.

VI. Failure (unexpected failure of a therapy)- awareness under general anaesthesia.

VII. Non-compliance with prescribed medicines frequently produces adverse effects. Fault of patient for appropriate use of medication is known as patient non-compliance.

Nature of consequences depends upon type of error. It may occur due to, types of error. It may occur due to,

1. Underutilization of medication
2. Overutilization of medication
3. Miscellaneous factors

1. Underutilization of medication: It occurs due to missing of doses or failure to get the prescription filled in & causes large number of therapeutic failure. If physician is unaware about the patients underutilization of drug, physician may change the potency of drug or frequency of its administration which will increase the risk of dose related adverse effects & drug toxicity

Ex.:

- TB patient on Isoniazid therapy may develop resistance if they miss the dose. In such cases relapse is more common.
- Missing even a single dose of contraceptive pill can result in unwanted pregnancy .
- Underutilization of anticonvulsant drugs may lead to uncontrolled seizures or even death.
- Missing doses of antihypertensive like Propranolol, Clonidine can cause rebound hypertension.

2. Overutilization of medication:

- It may occur if the patient think that double dose of drug will provide better & fast relief than a single dose.
- Sometimes patient may consume double dose if he has missed previous dose.
- It may cause serious health hazards & makes patient prone to dose related adverse drug reactions.

3. Miscellaneous factors:

- Non-compliance may arise through,

- Improper technique of drug administration
- Using a medicine for wrong purpose
- Consuming outdated medicine.

III. STRATEGIES TO MINIMIZE MEDICATION ERRORS

To prevent medication error over the years hospital have developed strategies. Following strategies are use to reduce medication error.

- Double check the frequency and dosing of all high alert medication. A list of high alert medication is provided by the Institution of Safe Medication practices.
- If not sure about the dose of the drug , consult to pharmacist.
- If the illegible writing, do not give the medication believing that you think you know what it is. To confirm the drug or dose call the health care provider.
- Recheck the calculation to confirm that the patient will get the right therapeutic dose l.
- Ask another clinician to recheck your calculation.
- For each medication always write one prescription.
- Do not sign the prescription; on the pre-printed prescription pad always circle your name.
- When writing a prescription, state the treatment condition.
- When writing orders do not use drug abbreviations.
- To each prescription always add the patient's weight and age.
- Do not use abbreviation, write full forms of the route and frequency of dosage.
- Always specify the duration of he therapy; do not say give out "XXX" number of your left.
- 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.
- Always be aware of high-risk medication.
- Before ordering any medication check for the liver and renal function.

Impact of medication error

Medication error can have serious consequences. The impact can be divided into three main Categories:

1.Impact on patients:

- Adverse drug reaction: Unintended side effects or toxicity.
- Therapeutic failure: The intended effects of medicine is not achieved.
- Hospitalization or prolongated stay: Due to complications.
- Disability or death: In severe cases, especially with high risk drugs.
- Loss of trust in health care system: Patients may loss confidence in treatment.

2. Impact on health care provider:

- Legal consequences: Lawsuits and professional liability.
- Emotional stress: Anxiety, guilt and burnout.
- Professional reputation damage: Loss of credibility and trust.
- Job related consequences: Suspension or loss of license.

3.Impact on Healthcare system:

- Increased health care cost: Due to additional treatment,investigation,and longer hospital stay.
- Wasted resources: Time,staff efforts, medication.
- Reduced efficiency and safety: Decreased overall quality of care.
- Regulatory actions: Penalties, Audits or system-wide review.

LASA drugs and medication error

To minimize medication error caused by LASA (Look-Alike Sound-Alike) drugs, the following methods are commonly used:

1. Tall man lettering: Use upper case letters to highlights difference in similar drugs name.

Example: hydrOXYzine vs hydrALAZINE

2. Separate storage: Store LASA drugs in different locations or bins with clear labels to prevent mix-ups.
3. Barcode scanning: Implement barcode scanning during dispensing and administration to verify the correct drug.
4. Education and Training: Regular training for healthcare staff on LASA drugs and strategies to avoid confusion.
5. Use of Generic and Brand names: Mention both generic and brand names on prescription and labels to reduce ambiguity.

6. Clear Labelling and Packaging: Use large fonts, different colours on warning labels on LASA medication.
7. Computerized Physician Order Entry (CPOE): Use electronic prescribing systems with alert functions for LASA drugs.

Drug-Drug interaction (DDI) as a Cause of Medication Error

A drug-drug interaction occurs when one drug effect the activity of another when both are administered together. This can lead to increased toxicity, reduced therapeutic effect ,or unexpected side effects- a common cause of medication errors.

Types of Drug-Drug Interaction:

1.Pharmacodynamic interaction:

- Occurs when drug have additive, synergistic or antagonist effects.
- Example Warfarin + Aspirin- Increased risk of bleeding.

2.Pharmacokinetics interaction:

- One drug affects the absorption, distribution, metabolism or excretion of another.
- Example: Rifampicin +oral contraceptives- Reduced effectiveness of contraceptives.

Common Causes of DDI Medication Errors:

- Lack of knowledge about drug interactions.
- Polypharmacy (using multiple medications at once.)
- Inadequate medication history (e.g. unaware of OTC or herbal medicine.)
- Improper use of interaction-checking tools.

Prevention of DDI Medication Error:

- Use drug interaction checkers (software or apps.)
- Maintain updated medication history including OTC or herbal products.
- Educate patients on reporting all medications they use.
- Monitor closely when initiating or changing drug therapies.
- Train healthcare professionals regularly in high risk interaction.
- Use clinical decision support system (CDSS) in electronic health records.

Drug- Food interaction as a Cause of Medication Error

Drug-Food interaction occurs when food affect the absorption, metabolism, or action of a drug, leading to reduced effectiveness or increased toxicity. These interactions are significant yet often overlooked cause of medication errors.

Types of Drug-Food Interactions:

1.Altered Absorption: Example- Tetracycline with milk- calcium binds the drug, reduced its absorption.

2. Increased Toxicity: Example- Tyramine-rich foods(cheese, wine) + MAO inhibitors- Hypertensive crisis.

3.Reduced Drug Effects: Example- Warfarin + vitamin K rich foods (spinach, broccoli)- Decreased anticoagulant effects.

4.Delayed or Enhanced Absorption: Example- Grapefruit juice+ statins- inhibit metabolism and increased drug levels or toxicity.

Common Causes of Drug-Food Interaction Error:

- Lack of patient counselling about dietary restrictions.
- Not reading medication labels or instructions properly.
- Unawareness of timing (e.g. taking on an empty vs. full stomach).
- Over-the-counter or herbal product use (e.g..St. John's Wort.)

Prevention of Drug-Food Interaction Errors:

- Provide clear instructions on food-drug timing (before/after meals.)
- Educate patients on specific foods to avoid with certain drugs.
- Use medication labels with warning symbols or statements.
- Train healthcare professionals to identify high risk interactions.
- Use clinical tools and apps for checking food-drug interactions.
- Encourage patients to ask questions about food interactions.

Prevention and Control Measures of Medication Error:

Medication error can occur at any stage of the medication process. Effective prevention and control require a systematic and proactive approach involving healthcare professionals, patients, and healthcare systems.

1.Prevention Measures

1) Prescribing stage:

- Use electronic prescribing systems to reduce handwriting errors.
- Avoid ambiguous abbreviations (e.g. write “units” instead of “U”.
- Check for drug interactions and allergies before prescribing.
- Use standard treatment protocols and guidelines.

2) Transcribing stage:

- Minimize or eliminate manual transcription through digital tools.
- Verify orders for clarity and completeness.

3) Dispensing stage:

- Implement barcode scanning to match prescriptions with medications.
- Use Tall Man Lettering for LASA(Look-Alike, Sound-Alike) drugs.
- Store LASA drugs separately.
- Double-check labels,dosages,and patient information.

4) Administration stage:

- Follow the Five Rights:Right patient, Right drug, Right dose, Right route, Right time.
- Use medication administration records (MARs).
- Educate and engage patients in their treatments.

5) Monitoring Stage:

- Observe for side effects or adverse drug reactions.
- Report and document any unexpected reactions or errors.

6) System-level stage:

- Continuous staff training and education.
- Implement a non-punitive error reporting system.
- Regular audits and feedback.
- Improve communication among healthcare providers.

2.Control Measures:

1) Education and training:

- Regular training programs for healthcare professionals of safe medication practices.
- Keep updated on new drugs, protocols, and interaction risks.

2) Standardization:

- Use of standard drug charts, protocols, and abbreviations.
- Implement clinical decision support system (CDSS).

3) Communication:

- Improve communication during handoffs and between team members.
- Use SBAR (Situation, Background, Assessment, Recommendation) for clear communication.

4) Reporting System:

- Encourage a non-punitive medication error reporting system.
- Analyse errors to identify root causes and prevent recurrence.

5) Audit and Feedback:

- Conduct regular audits of medication practices.
- Provide feedback to improve practices and reduced errors.

CASE STUDY 1

Abstract: Medication error remain a significant concern in health care settings, often leading to adverse patient outcome. This case study highlights a dosing error involving insulin in a hospitalized patient, analysing contributing factors, the outcome, and measures taken to prevent recurrent.

Introduction: Medication error are preventable events that may cause or lead to inappropriate medication use of patient harm. Common cause include human error, communication failures, and system issues. Insulin is a high-alert medication where dosing accuracy is critical.

Case presentation

- Patient Details:
  - A 58- year- old male with Type 2 Diabetes Mellitus.
  - Admitted for diabetic foot ulcer and scheduled for surgery.

- Medication Error:
  - Prescribed: Insulin Glargine 10 units subcutaneously at bedtime.
  - Administered: Insulin Glargine 100 units due to a transcription and misreading of physician’s handwriting.

- Time of Error: Night shift at 10:00 PM.

Consequences:

- Patient developed hypoglycaemia (Blood glucose: 42 mg/dL) at 2:00 AM presented with sweating, confused, and also low consciousness treated with 50% dextrose IV and recovered after 3 hours.
- No permanent damage, but prolonged hospital stay by 2 days.

Root Cause Analysis:

- Illegible handwriting on the prescription chart.
- Lack of double-checking before administration.
- Inadequate staff tanning on high alert medications.
- No barcode scanning system in use.

Preventive Measures Taken:

- Implementation of electronic prescribing (E-prescriptions).
- Mandatory double -check for high- alert drugs like insulin.
- Staff re-training on medication safety protocols.
- Introduction of barcode medication administration (BCMA).

Discussion: This case demonstrates how simple error can escalate when safety checks are absent. The use of technology, improve communication, and continuous education are crucial in preventing such events. Hospital must enforce a safety culture where reporting and learning from near-misses is encouraged.

Conclusion: Medication error can be life-threatening but are often preventable. A multifactorial approach involving human, technical, and organizational strategies is essential to minimize such incidents and enhance patient safety.

CASE STUDY 2

Abstract: Medication errors can put a patient's health in danger.

This case study shows a medication error that happened with paracetamol in a hospital.

It explains what went wrong, how it affected the patient, and what can be done to avoid it in future.

Introduction: Medication errors happen when the patient gets the wrong medication or the wrong amount of medication. Paracetamol is a common painkiller and fever-reducer, but a large overdose can harm the liver.

Case presentation

- Patient Details:

45-year-old women with high fever and body pain she was admitted to the hospital for observation and treatment.

- Medication Error:

Prescribed: paracetamol 500mg 4 times a day

Given: paracetamol 1000mg 4 times a day, due to confusion in reading the prescription

- Time of error:

Evening medication round at 6:00 pm

Consequences:

- The patient received twice the intended amount of paracetamol
- She started experiencing nausea and weakness
- The doctor was informed immediately
- Test were done to check liver enzymes levels
- Support medication (N-acetyl cysteine) was given to help protect her liver
- The patient recovered safely after 2 days and was discharged
- Root Cause analysis

Incorrect reading of prescription due to poor handwriting

Nurse did not double-check the medication against the prescription

There was no policy to double-check medication in cases of large dosage

Preventive Measures Taken:

- Nurses were trained to double -check medication against the prescription.
- The hospital implemented a policy for high-risk medication to be double- checked by a second nurse.
- The pharmacy department started using computer-printed medication charts to avoid confusion from poor handwriting

Discussion

- This case show how a small mistake can affect patient health.
- Using careful checks,training,and clear prescription charts can help avoid medication errors in future.
- Patient safety must be the first priority in medication administration.

Conclusion: Medication error are a serious problem in health care, but we can avoid them by proper training, double check, and clear communication. Prevention is the best way to keep patients safe.

CASE STUDY 3

Paediatrics asthma – Inhaler misuse due to counselling error

Background: Asthma in children requires precise medication use. Confusing between short acting and long acting Inhalers can be fatal during exacerbations

Description of Incident: An 8-year-old boy with asthma was prescribed salmeterol (LABA) for maintenance therapy salbutamol (SABA) for rescue . Due a counselling error by the physician, the mother was told to use "the blue inhaler" during asthma attacks , which was actually salmeterol.

Clinical outcomes: During an acute asthma episode, the mother administered salmeterol, the child's condition deteriorated and he was rushed to the ER with severe bronchospasm, requiring nebulization, steroids and oxygen therapy.

Analysis:

- Type of error : Patient education and counselling error
- Root cause :
  - Inadequate counselling
  - Assumption that caregivers can identify the inhalers by colour.
- Contributing factor : No return asthma action plan provided.

Prevention Measures:

- Provide asthma action plans with colour coded pictorial guides.
- Involve pharmacist in counselling for device use.
- Demonstrate inhaler use and check caregiver understanding before discharge.
- Use spacers and label device with large , clear stickers.

CASE STUDY 4

Chronic Kidney Disease(CKD)- Nephrotoxic Drug Prescription

Background: Patients with CKD are highly susceptible to nephrotoxic medications. NSIDs are contraindicated in patients with reduced renal function due to the risk worsening kidney injury.

Description of incident: A 70-years-old male undergoing haemodialysis for CKD stage-5 presented with joint pain. The general practitioner prescribed ibuprofen-400mg three times daily for 5 days without checking the renal function.

Clinical Outcome: Within four days, the patient developed signs of fluid overload, rising creatinine, and breathlessness. Hospitalization was required for emergency dialysis and supportive care.

Analysis:

- Types of error: Prescribing error (contraindicated drug)
- Root cause: Failure to consider renal function during prescription. No electronic alerts for renal dosing.

Contributing factors: No medication reconciliation or pharmacy envolvement.

Prevention measures:

- Integrate renal dose calculator into prescribing systems.
- Automatic alerts for naphrotoxic drugs in CKD patients.
- Encourage physician-pharmacist collaborative care models.
- Educate general practitioners on renal dosing guidelines.

CASE STUDY 5

Tuberculosis- Overdose of Fixed-Dose Combination (FDC)

Background: Tuberculosis treatment involves FDCs that combine multiple drugs. Errors in administration or duplication that lead to toxicity.

Description of incident: A 30 years old female with active pulmonary TB was enrolled under the DOTS program. She was receiving a daily FDCs under supervision. Due to poor communication, both the DOTS nurse and the attending physician administered the FDC on the same day.

Clinical outcome: The patient developed hepatotoxicity, with ALT / AST levels rising threefold. She complained of nausea, fatigue, and yellowing of eyes. Treatment was and liver function monitored for 2 weeks.

Analysis:

1. Type of Error: Duplication of therapy
2. Root cause:

- Inadequate documentation and communication
- No standard administration log maintained
- No standard administration log maintained
- Contributing Factors: No tracking mechanism for medication administration.

Prevention Measure:

- Maintain a centralized TB treatment record uncared by all healthcare workers
- Train staff on anti-TB drug toxicity and reporting
- Implement nurse checklist to avoid duplicate dose

Discussion: These five cases presented in this study demonstration that medication error are multifactorial and disease- specific. Errors range from administration, prescribing, and counselling to documentation failures. Key root causes include LASA medications, lack of EHR safeguards, Inadequate counselling, and poor interprofessional communication. Each scenario reinforces the importance of system-level intervention, such as EMR optimization, clinical decision support, and team-based care.

Conclusion: Medication error cause serious risks to patient safety, especially in chronic and high-risk diseases. Comprehensive strategies- encorporating technology, education, system redesign and interdisciplinary communication-are essential to mitigate these errors. By learning from real-life cases, healthcare system can implement targeted prevention protocols and foster a culture of safety.

IV. CONCLUSION

Medication errors remain a significant challenge in healthcare systems worldwide, contributing to patient harm, increased healthcare costs, and reduced trust in medical services. This research highlights that the causes of medication errors are multifactorial, including human errors, communication failures, loom-alike/sohne-alike (LASA) drugs and system related issues.

Prevention strategies such as proper staff training, implementation of electronic prescribing, double checking high alert medication and fostering a culture or safety are essential to minimize these errors. Continuous monitoring, reporting and analysis of medication errors are vital for developing targeted interventions. By prioritizing patient safety and improving medication practices, healthcare institutions can significantly reduce the occurrence and impact of medication error.

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