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A Comprehensive Review of Medication Errors in Healthcare: Analyzing their Causes, Categories, and Prevention Methods in India

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Abstract: Medication errors pose a significant challenge in healthcare, potentially leading to harmful consequences, increased hospital stays, and rising medical costs. Such errors encompass any avoidable incidents arising from improper medication administration or patient harm during care provided by healthcare practitioners, patients, or caregivers. Medication errors can occur at any stage of the medication process, including prescribing, dispensing, administering, transcribing, and monitoring. Pharmacists, alongside doctors, nurses, and administrators, play a crucial role in evaluating and improving the healthcare system to ensure patient safety. These errors contribute to increased illness rates, higher healthcare costs, and a decline in patients' trust in the healthcare system.This article reviews the literature on medication errors, their types, causes, and prevention approaches. The main contributing aspects to medication errors include patient-related aspects, healthcare provider-related aspects, and system related aspects. Understanding the different kinds and causes of medication errors is key to develop effective prevention strategies to decrease the medication error rates. Countries like India, which are developing rapidly, urgently need to implement specialized training programs to enhance the prescribing skills and knowledge of healthcare providers, while also promoting the advancement of nurses' drug administration practices. Several strategies for preventing medication errors have been identified, and their effective application can significantly enhance healthcare services. This review article aims to emphasize the critical role of healthcare professionals, identify the different types and causes of medication errors, and discuss effective strategies for their prevention.

Keywords: *Medication Errors, Types of Errors, Causes of Error, Preventive Strategies.*

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I. INTRODUCTION

It is universally acknowledged that medication therapy is a vital component of modern healthcare. The intricate process of prescribing and managing medications often leads to errors, which can significantly impact patient health, resulting in increased mortality and morbidity. Concerns about medication errors have existed since the introduction of pharmaceuticals in medical practice. “Any preventable incident that may result in improper drug usage or patient harm when the medication is within the control of patients, healthcare providers, and consumers.” refer as Medication Error according to NCCMERP. Medication errors can happen at any stage of the medication management process, including transcribing, administering, prescribing, dispensing, and monitoring. Pharmacists, in collaboration with doctors, nurses, and administrators, play a crucial role in evaluating and enhancing the healthcare system to ensure patient safety [1].

Medication errors increase illness rates, strain healthcare costs, and undermine patients' trust in healthcare settings. Several factors heighten the risk of medication errors, including individuals with severe health conditions, the elderly, pediatric patients, and those on multiple prescribed medications. Errors can arise from a lack of information, subpar performance, and psychological stress among healthcare providers. Both experienced and novice staff, such as pharmacists, physicians, nurses, students, and others, can commit medication errors. It's crucial to understand that medication errors differ from adverse drug events; while errors may not always cause harm, adverse drug events result from medication errors that lead to actual patient harm. Assessing these errors and identifying factors that

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contribute to them can be highly beneficial. Additionally, most studies focus on errors of commission, often overlooking errors of omission, which can give a misleading impression of a lower frequency of medication errors.

Patient safety has become a critical concern in healthcare environments, with medication errors receiving considerable focus due to their serious consequences. [2].

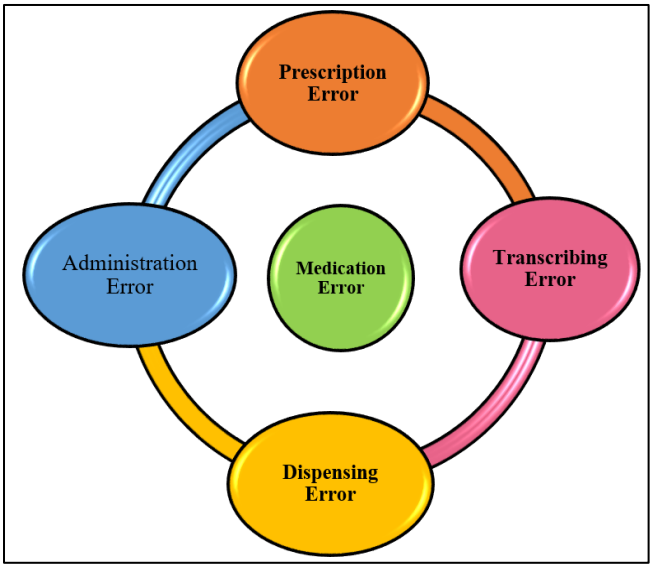

Fig1 Types of Medication Errors

➢ *Prescription Error:*

Prescription error can be defined as a set of planned acts that may not produce the expected result, according to theories of human error, because actions did not go as planned or because the plan was insufficient [3]. The prescribing error is a common drug error that can be prevented in hospitals around the world [4]. Prescription errors can be categorized into various types, including errors related to the administration route, incorrect dosage, improper frequency, wrong dosage form, and omission errors associated with the prescriber (such as incorrect patient information, prescriber details, patient's department visit, and diagnosis). Additionally, commission errors encompass mistakes like prescribing the wrong drug strength, incorrect drug name, inappropriate dosage form, and potential drug-drug interactions [5].

➢ *Dispensing Error:*

Dispensing errors refer to any discrepancies between the prescribed instructions on the prescription order and how they are executed by the pharmacy when providing medication to patients or hospital staff. Different hospital units utilize various medication dispensing systems, each with its own set of expectations regarding potential errors [6]. Common dispensing errors include missed doses, omitted items, incorrect patient and medication names, and inaccurate patient details. One potential cause of these errors is that some pharmacists may fail to verify patients' identification before dispensing medication. [7].

➢ *Administration Error:*

The most frequent errors committed by nursing staff during medication administration involve mistakes such as giving medications to the wrong patient, incorrect prescriptions, inaccurate instructions, wrong dosages, inappropriate indications, timing, and duration. Other errors in drug administration include using improper techniques and administering incorrect or expired medications. Two key factors that contribute to these errors are failing to verify the patient's identity before giving medication and storing similar medications in the same location, which can lead to confusion. [8, 9].

➢ *Monitoring Error:*

A monitoring error occurs when prescribed medication is not observed in accordance with established standards of care in routine clinical practice. This includes situations where tests are not conducted at the recommended frequency, with a tolerance of up to 50%. However, if a patient refuses to consent **to** a test, it is not considered a monitoring error. [10].

Table 1 Commonly Misinterpreted Abbreviations, Symbols, and Dosage Notations

S. No.	Abbreviations	Intended Meaning	Misunderstood	Correction
1.	U	Units	Mistaken as 0 or 4 leading to overdose.	Use "unit"
2.	Ug	Micrograms	Mistaken as "mg"	Use "mcg"
3.	D/C	Discharge or Discontinue	Premature discontinuation of medication if D/C (intended to mean discharge)	Use"discharge" and"discontinue"
4.	SC or SQ	Subcutaneous	SC mistaken as SL(sublingual)	Use "subcut" or "subcutaneously"
5.	IU	International Unit	Mistaken as 10 or IV (intravenous)	Use "International unit"
6.	q.d. or QD	Everyday	Mistaken as Q.I.D.	Use "daily"
7.	o.d. or OD	Once daily	Misinterpreted as QD (daily)	Use "daily'
8.	HS	Half-strength	Mistaken as Bedtime	Use "half-strength"
9.	T.I.W	Three times a week	Mistaken as 3 times a day or Twice in a week	Use"3 times weekly"
10.	BT	Bedtime	Mistaken as BID "Twice daily"	Use "bedtime"
11.	IN	Intranasal	Mistaken as IV or IM.	Use "intranasal" or "NAS"
12.	Cc	Cubic centimetre	Mistaken as u "unit"	Use "ml"

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II. REASONS OF MEDICATION ERRORS

The causes of medication errors are complex and typically involve a combination of human, systemic, and environmental factors. The following section provides an in-depth analysis of the various factors contributing to medication errors:

➢ *Human Factors:*

- *Lack of Knowledge or Training:*

Lack of understanding of pharmacology, drug interactions, or dosing advices may lead to medication error due to prescribing or administering the wrong drug or medication.

- *Over Workload and Pressure:*

Healthcare professionals especially those working extended shifts or under high-pressure circumstances, may become exhausted or stressed, damaging their ability to make precise decisions.

➢ *Systemic and Organizational Factors:*

- *Unsuitable Labeling or Packing of Drug:*

Poor labeling or unclear packaging can lead to misinterpretation of the medication's dosage or administration directions.

- *Poorly Planned Workflow:*

Medication errors might occur when the physical environment or workflows do not ease suitable attention to detail. For example, poorly organized medication carts, inadequate lighting, or high noise levels in a healthcare setting can lead to turbulences or faults which can cause medication error.

➢ *Medication-Related Factors:*

- *Multi-Layered Drug Regimens:*

Patients who are on multiple medications have higher risk of errors due to the complex nature of drug interactions and dosage modifications. Complex regimens with multiple steps, like the administration of intravenous drugs, may lead to mistakes if not carefully followed.

- *Look-Alike, Sound-Alike Drugs:*

Medications with similar names (e.g., "lamotrigine" vs. "lamivudine") or similar appearances (e.g., similar color, shape, or size of tablets) can be mistaken for one another.This concern is mainly prevalent when drugs are stored unsuitably or not clearly labeled.

➢ *Patient-Related Factors:*

- *Non-Disclosure of Medical History:*

Patients may fail to tell their full medical history, including allergic condition, previous medication use, or underlying illnesses, which could lead to incorrect prescriptions or unsafe drug interactions.

- *Medication Misuse or Non-Compliance:*

Patients may not follow prescribed instructions, taking incorrect doses or skipping doses, leading to ineffective treatment or adverse effects. Self-medication or use of over-the-counter drugs alongside prescribed medications can lead to harmful interactions.

➢ *Pharmacological Factors:*

- *Drug Interactions:*

Few medications might interact with others, altering their effectiveness or leading to harmful side effects. These interactions may not constantly be anticipated, particularly with new or unusual drug combinations.

- *Changes in Pharmacokinetics:*

Changes in a patient's health status (e.g., renal or liver dysfunction) can alter how a drug is absorbed, metabolized, and excreted, requiring dose adjustments to avoid adverse effects [11,12,13].

➢ *Role of Health Care Professionals in Medication Error:*

- *Prescribers' Contribution to Prescription Errors:*

These errors occur when the prescriber's written instructions are unclear, incomplete, or contain inaccuracies that are typically expected to be clearly communicated. Such errors may involve the selection of inappropriate medication, incorrect dosage, or improper dosing regimen, all of which can pose a risk of harm to the patient. [14]. "Prescription errors (PEs) occur when a prescribing decision or the process of writing a prescription unintentionally leads to either a significant decrease in the likelihood of timely and effective treatment or an increased risk of harm." PEs typically arises during two key stages of the prescribing process. The first is the decision-making stage, where the prescriber selects the most appropriate medication for the patient. This requires a comprehensive review of the patient's medical history and a thorough physical examination; neglecting these steps can result in irrational prescribing. [14, 15].

- *The Role of Pharmacists in Dispensing Errors (DEs):*

Dispensing errors occur when incorrect medication is provided to a patient. These errors often result from discrepancies between the prescription and the medication dispensed by the pharmacist. While the correct drug may be supplied, issues can arise from incorrect dosage, dosing regimen, route of administration, or even dispensing the medication to the wrong patient. [16]. DEs can be categorized into three types: failure to identify and correct prescription errors, failure to detect errors from manufacturers, and inadequate patient counseling. These errors reflect shortcomings in quality assurance and pharmaceutical care, which fall under the primary responsibilities of the pharmacy team. Given that the pharmacy acts as the central control point for medications, thorough prescription review and precise dispensing are crucial for protecting patients from various types of medication errors.

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- *The Contribution of Nurses to Drug Administration Errors (DAEs):*

Drug administration errors **occur** when medications are given in a manner that does not align with the prescription order. They can also result from failures to identify and correct errors made during prescription, transcription, dispensing, and the final administration of the drug [17, 18]. The prevalence of DAEs can be assessed by evaluating their occurrence rate, with observational methods being the most effective approach [17]. Research indicates that the prevalence of DAEs ranges from 14.9% to 32.4% [17, 19, 20]. Additionally, the rate of errors is notably higher when administering intravenous medications compared to other types of drugs [17].

- *Strategies for Preventing Medication Errors:*

Preventing medication errors involves addressing the shortcomings of individual healthcare professionals, systemic failures, and the challenge of underreporting incidents. Three key strategies are commonly employed to address medication errors: enhancing medication safety practices, implementing measures to reduce the occurrence of errors, and establishing effective systems for reporting and providing feedback on medication errors.

✓ *Strategy to Enhance Medication Safety:*

The first step in preventing medication errors is to enhance medication safety by ensuring the availability of essential resources, such as reference books, journals, and online tools, within the hospital. This should be supported by a collaborative work environment and a well-staffed workforce. The Commission on Quality of Health Care in America (CQHA) has developed strategies aimed at improving treatment processes and promoting patient safety [21]. The strategies involve the development of standardized prescription guidelines, offering thorough information to patients, implementing electronic prescribing software, and prescribing medications by their generic names. The monitoring and evaluation of prescription errors (PEs) should be carried out by the drug and therapeutic committee. [22]. The committee recommended that all medications and related products be stored in the designated drugstore. High-risk drugs should be supplied to wards only when needed. Similar medications and equipment should be kept apart, and pharmacists should offer clear guidance to both patients and nurses. Furthermore, druggists should collaborate with the drug and therapeutic committee to identify, report, and manage medication errors. [23].

✓ *Strategy to Decrease Medication Error:*

To reduce medication errors linked to individual healthcare providers and systemic issues, three approaches have been adopted: the implementation of barcoding, the use of physician computer order entry (CPOE), and the integration of pharmacists into clinical practices. [22, 24-25]. The use of barcoding verifies that the prescriber, pharmacist, or nurse is giving the correct medication to the right patient, in the proper dose, at the right time, and through the correct route. This method is highly reliable, with less than one error occurring per million scans. [24]. The prescriber typically uses a bar-code to link a prescription to the correct patient before sending it to the pharmacist. The pharmacist then dispenses the medication based on the bar-code information and passes it to the nurse. The nurse uses the bar-code scanner to verify that the medication is being administered to the right patient. [22]. CPOE includes the usage of computer by prescriber to send prescription to the pharmacy using specific patient information. This system was implemented to lessen the Prescription Error by 83% [24, 26]. Another study indicated that CPOE has significantly reduced the incidence of ADRs due to MEs by 55% [22]. The physician typically diagnoses the patient and enters the diagnosis into the computer, which then analyzes the risk of allergies, drug incompatibilities, and interactions based on the patient's documented medical history and diagnosis. The resulting prescription usually includes the correct medication, proper dosage, and appropriate dosage form for the intended patient. [22, 26]. Pharmacists play a vital role in clinical settings, contributing to quality assurance and effective patient care. Their involvement in healthcare teams enhances patient outcomes, promotes the rational use of medicines, and supports the prompt identification and reporting of adverse drug reactions (ADRs) and medication errors (MEs) [22].

✓ *Reporting and Feedback Regarding Medication Error:*

Medication errors reporting is essential for understanding the types and causes of medication errors and for creating effective prevention strategies. To encourage reporting, the process should be straightforward and user-friendly. Healthcare providers should be educated about the importance of reporting medication errors and their professional obligations in this area. To ensure confidentiality, medication error reports should be kept private, and in certain situations, the identity of the reporter may need to be concealed. Prompt reporting after an error is detected is crucial, as it enables healthcare specialists to take immediate action to prevent adverse drug reactions [27]. The following step is to distribute this information among healthcare professionals to help prevent future occurrences. Research indicates that medication errors can be effectively evaluated, identified, and reported through active intervention strategies, including chart reviews and patient observations. This method has been shown to be ten times more effective in managing medication errors and adverse drug reactions than relying on spontaneous reporting [27]. The comprehensive process of active intervention involves the proactive identification of medication errors, a reporting and feedback control system, enhancing the knowledge of all healthcare professionals, and simplifying the complex procedures related to prescription, drug administration, and dispensing. [28].

III. CONCLUSION

All healthcare professionals are responsible for recognizing the factors that contribute to medication errors and using this knowledge to reduce their occurrence. This review aimed to identify scientific literature that has evaluated and documented medication errors. Although focused on medication errors, our findings revealed that inadequate knowledge of medications was a significant factor

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leading to drug administration errors among both prescribers and nurses.

Medication errors are caused by a combination of factors and require a multidisciplinary approach, emphasizing that no one is exempt from making mistakes. It is important to assess the knowledge, attitudes, and practices of medical doctors regarding medication errors before starting patient treatment. The involvement of pharmacists in clinical activities is crucial for reducing medication errors.

All healthcare professionals should adopt Evidence-Based Medicine (EBM), which involves the careful, explicit, and informed use of the best available evidence to guide decisions about patient care.

To improve patient safety, healthcare providers must understand how to define and classify medication errors, as well as recognize the potential harm these errors can cause to patients. Additionally, healthcare professionals should be encouraged to report medication errors without fear of career-related consequences, and safety protocols should be implemented as extensively as possible. More research is needed to understand healthcare workers' knowledge, attitudes, and practices concerning medication errors in different clinical settings.

SUGGESTED RECOMMENDATIONS

➢ *Based on the Findings of this Review, the Following Recommendations are Proposed to Assist Decision-Makers in Developing Effective Medication Safety Strategies and Reducing Medication Errors:*

- Increase awareness among healthcare providers about the risks and implications of medication errors.
- Encourage prescribers to exercise greater caution when determining drug dosages.
- Strengthen medication error reporting systems and organizational policies by removing barriers, emphasizing the importance of reporting, and motivating healthcare professionals to report errors.
- Future studies should evaluate the clinical significance of medication errors.
- Introduce regular pharmacotherapy education and training for undergraduate medical and paramedical students.
- Urgently implement educational initiatives led by clinical pharmacists and pharmacologists to enhance doctors' and nurses' understanding of drug therapy.
- Ensure continuous training for healthcare professionals on medication safety, error reporting, and the effective use of technology.
- Healthcare administrators should develop and maintain standardized protocols, especially for medication administration.
- Expand the use of Computerized Physician Order Entry (CPOE), Barcode Medication Administration (BCMA), and Electronic Medication Administration Records (eMAR), coupled with regular evaluations to ensure proper usage.
- Given the higher risk of medication errors among elderly patients, healthcare providers should adopt a patient-centered approach that accounts for polypharmacy and the potential for drug interactions.

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