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Indian Journal of Pharmacy and Pharmacology

Journal homepage: https://www.ijpp.org.in/

Original Research Article

Impact of clinical pharmacist–led medication safety surveillance: A retrospective analysis of prospectively detected errors

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Abstract

Background: To evaluate the prevalence, types, severity, and contributing factors of medication errors (MEs) in a tertiary and quaternary care hospital over a four-year period, and to assess the impact of clinical pharmacists in identifying and reducing these errors.
Aim & Objective: To assess the prevalence, types, severity, and contributing factors of medication errors in a tertiary care hospital over a four-year period, and to evaluate the role of clinical pharmacists in identifying and reducing errors.
Materials and Methods: A retrospective observational study was conducted from January 2020 to December 2023 in a tertiary care hospital with 800-bed capacity. A total of 42,729 prescription charts from inpatient and critical care departments were analysed. Medication errors were identified through a hospital intranet reporting system and categorized by clinical pharmacists using the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) classification.
Results: A total of 551 medication errors were recorded. The majority were of mild severity (NCC MERP categories B and C), with a marked decline in error frequency over the study period. Critical care units reported 174 errors, primarily administration errors, while 377 errors were from inpatient units, with transcription errors being the most frequent in 2020. Only one severe error (Category G) was identified. Contributing factors included insufficient training, misinterpretation of dosing schedules, and lack of knowledge. The clinical pharmacists played a key role in identifying, reporting, and reducing errors through audits and staff education.
Conclusion: The study demonstrates a declining trend in medication errors over four years, largely attributed to the proactive involvement of clinical pharmacists. Most errors did not result in patient harm. Continuous training, system-level interventions, and enhanced pharmacist involvement are essential to further improve patient safety and healthcare quality.

Keywords: Medication errors, Pharmacist, Prescription, Clinical audit, Patient safety, Critical care, Retrospective study

Received: 07-01-2026; **Accepted:** 21-01-2026; **Available Online**: 02-02-2026

1. Introduction

Bates et al. defined medication error as "any error occurring in the medication use process" and focuses on problems with the delivery of a medication to a patient.[1] Importantly, although some medication errors cause harm to the patient, most do not (eg: "near misses").[2] The American Society of Health-System Pharmacists developed a system for categorizing medication errors based on prescribing, omission (ordered drug not administered), timing, use of an unauthorized drug (not authorized by a legitimate consultant), improper dosing, wrong dosage form, wrong drug preparation, wrong administration technique, deteriorated drug (an expired medication), monitoring (failure to use laboratory data to monitor toxicity or effect), compliance, and other errors. The American Society of Health-System Pharmacists also identified common causes leading to these errors, including drug product nomenclature, illegible handwriting, labeling errors, excessive workload (among physicians, nurses, or pharmacists), and medication availability (manufacturer shortages of medications).[3] The medication errors can be prevented by monitoring and identifying errors, reporting them in a blame-free environment, analysis of their root causes,[4] further improving the procedures that lead to medication errors and continuous training of health care professionals.

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https://doi:10.18231/j.ijpp.15167.1769489588

In healthcare systems around the world, medication errors are a major problem because they can cause harm to patients and financial difficulties. Longer hospital stays and the health damage caused by MEs place a significant financial and emotional strain on healthcare systems as well as the families of patients.[5-8]

Medication errors are highly common in a hospital setting. As awareness of medication errors have grown different detection methods have been developed to monitor the events. Voluntary reporting systems were the reports are typically drawn up by health care professionals, are one of the most commonly used methods. Spontaneous reporting, chart review, review of medical prescriptions, and direct observation are the main methods for identification and evaluation of medication errors. Each method has its advantages and disadvantages; the methods adopted should be adopted to institutional goals and used as management tool for healthcare quality improvement.

Common cause of medication error includes incorrect diagnosis, prescribing errors, dose miscalculations, poor drug distribution practices, drug and drug device related problems, incorrect drug administration, failed communication and lack of patient education.[13] Types of medication errors Prescription error, Transcription error, Dispensing error, Administration error, Missed dose, Therapeutic duplication.

2. Materials and Methods

We conducted a retrospective observational study at an 800-bed tertiary and quaternary care hospital (Hyderabad) covering 1 January 2020 to 31 December 2023. All adult inpatients, including critical care admissions, were eligible.

For every medication safety incident and for each prospectively checked prescription, any deviation from appropriateness (prescribing, transcription, dispensing, administration, monitoring) is documented in the Open Chart Reviews (OCRs). OCR entries include medication name, deviation type, severity (NCC MERP) categories A–I, contributing factors, and the immediate corrective action done. These data are compiled monthly and combined with voluntary incident reports submitted through the hospital intranet to maximize signal detection from both proactive review and frontline reporting, recognizing their complementary strengths.

Based on the monthly OCRs and incident reports, targeted trainings are conducted across all inpatient departments (IPDs) and critical care units, prioritizing units with the highest error density, recurring error phenotypes, or high-severity events with core topics including dosing schedules and renal/hepatic adjustments, high-alert drugs (e.g., insulin, concentrated electrolytes), therapeutic duplication, administration and smart-pump use, and monitoring protocols, prioritizing high-alert content given documented nursing knowledge gaps and barriers to consultation

The sampling frame comprised 42,729 prescription charts screened over the study period, yielding 551 unique medication errors. Primary outcomes were the distribution of error types and NCC MERP categories by year and by unit (critical care vs inpatient). We summarized counts and proportions by year and setting, and compared distributions across years. Because the study involves both an observational design and a quality-improvement context, we report setting, participants, variables, data source, measurement procedures, and context to enhance reproducibility and interpretability. We recognize the limitations of voluntary reporting (underreporting and severity bias) and concurrent detection methods and explicitly describe our data source and verification approach to improve transparency of medication-safety surveillance. **Table 1.**

Table 1: National coordinating council for medication error reporting and prevention (NCCMERP) classification

Questionnaire	A	B	C	D	E	F	G	H	I
Did the error happen?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Did the error reach the patient?	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Did it require any monitoring?	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Any necessary measures were required/ done?	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Did it cause any temporary harm?	No	No	No	No	Yes	Yes	No	No	Yes
Did it cause any permanent harm?	No	No	No	No	No	No	Yes	Yes	Yes
Did it cause any prolonged hospitalization?	No	No	No	No	No	Yes	Yes	Yes	Yes

2.1. Interpretation

A-No Error, B-An error occurred but the error did not reach the patient, C- An error occurred that reached the patient but did not cause patient harm, 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, E- An error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention, F-An error occurred that may have

contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization, G-An error occurred that may have contributed to or resulted in permanent patient harm, H-An error occurred that required intervention necessary to sustain life, I-An error occurred that may have contributed to or resulted in the patient's death.

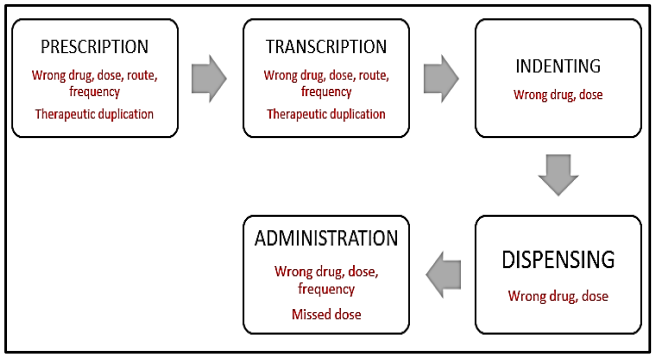

Figure 1: Flow of medication in an in-patient department and areas of error

3. Results

Data of 4 consecutive years was collected and analyzed for different types of errors. It was found that the number of errors was showing a declining trend from 2020 to 2021 and in the year 2022 and 2023 it was further decreasing.

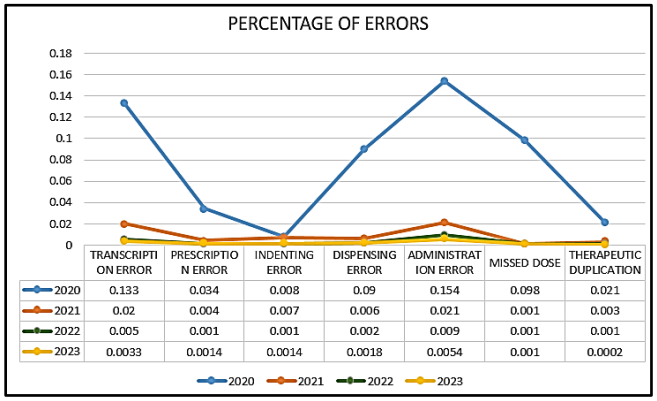

Figure 2: Percentage of errors for 3 consecutive years in a tertiary and quaternary care hospital

Table 2: Segregation of errors into different categories of NCCMERP classification of error for three consecutive years

Error category	2020	2021	2022	2023	P Value
A	0	0	0	0	-
B	102	43	30	25	0.0014*
C	111	38	61	21	0.3601
D	15	6	13	2	0.3267
E	6	6	16	2	0.0009*
F	0	2	1	1	0.1898
G	0	1	0	0	0.2369
H	0	0	0	0	0.0014*
I	0	0	0	0	0.3601

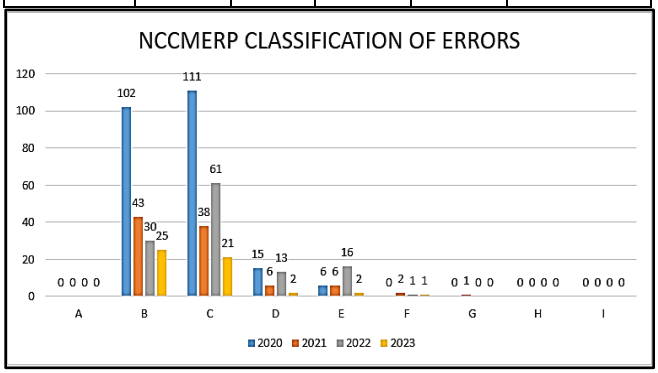

Figure 3: Segregation of errors according to NCCMERP classification

From the above data, **Table 2** & graphs we observe that most of the errors were falling into mild category (A, B, C) where harm to the patient was minimum. The errors in moderate category (D, E, F) were significant but they are also the ones that do not cause any remarkable harm to the patients. There was only one error that fall into G category i.e, severe category (G, H, I) that might have caused serious harm to the patient. Statistically significant difference was found only in the B and E error category between the years. There is a statistically significant difference found between the error categories and years (P value is 0.0007*)

The errors in critical care department and in-patient departments were separated to assess the rate of their occurrence in different set of patients as depicted in the following tables (**Table 3** & **Table 4**).

The errors in the critical care department and the inpatient departments were analysed separately to evaluate the occurrence rate in different patient groups, as shown in the following tables (**Table 3** & **Table 4**)

Statistically significant difference was found only in the administration error in in-patient department between the years.

There is no statistically significant difference found between the types of medication errors in in-patient department and years (P value is 0.0625)

Whereas, statistically significant difference was found only in the prescription error and missed dose error in critical care department between the years.

There is a statistically significant difference found between the types of medication errors in critical care department and years (P value is 0.0007*)

Table 3: Types of medication errors in in-patient department

Types of error	2020	%	2021	%	2022	%	2023	%	P value
Transcription error	35	25%	28	34.5%	30	28.3%	12	24%	0.4293
Prescription error	10	7.1%	5	6.1%	5	4.7%	3	6%	0.8915
Indenting error	15	10.7%	7	8.6%	5	4.7%	3	6%	0.3496
Dispensing error	29	20.7%	11	13.5%	11	10.3%	6	12%	0.1217
Administration error	27	19.2%	24	29.6%	41	38.6%	20	40%	0.0030*
Missed dose	18	12.8%	2	2.4%	8	7.5%	5	10%	0.0644
Therapeutic duplication	6	4.2%	4	4.9%	6	5.6%	1	2%	0.7751

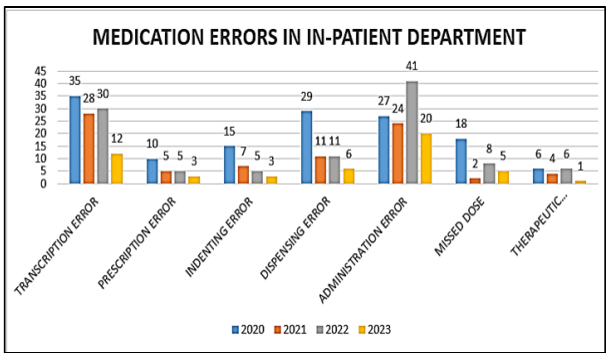

Figure 4: Medication errors in in-patient department in three consecutive errors.

Table 4: Types of medication error in critical care department.

Types of error	2020	%	2021	%	2022	%	2023	%	P value
Transcription error	15	16.1%	8	25%	4	14.2%	4	19%	0.6665
Prescription error	3	3.2%	3	9.3%	6	21.4%	4	19%	0.0096*
Indenting error	18	19.3%	6	18.7%	1	3.5%	4	19%	0.2481
Dispensing error	5	5.3%	0	0	1	3.5%	3	14.2%	0.1413
Administration error	31	33.3%	13	40.6%	13	46.4%	6	28.5%	0.4937
Missed dose	19	20.4%	0	0	0	0	0	0	0.0003*
Therapeutic duplication	2	2.1%	2	6.2%	3	10.7%	0	0	0.1458

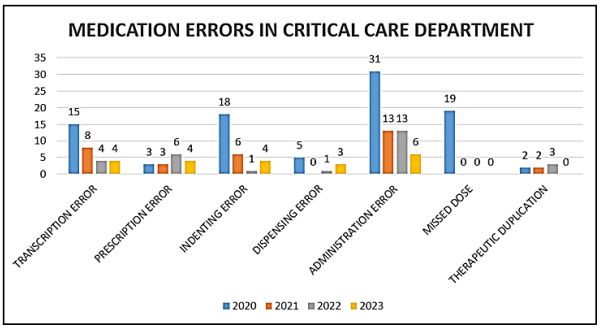

Figure 5: Medication errors in critical care department for 3 consecutive years in a tertiary care hospital

4. Discussion

This is a retrospective interventional study in a tertiary and quaternary care hospital including data of 4 consecutive years in which we have screened 42,729 inpatient and ICU prescription charts screened; 551 unique medication errors verified and analyzed. The data was collected from the Intranet-based incident reporting system done by all healthcare professionals from in-patient units and intensive care units which were spontaneous plus clinical pharmacist daily audits documenting the deviations in the OCRs. Daily prospective surveillance involves auditing active inpatient and ICU medication charts, reconciling incident reports, and proactively identifying new errors. Each incident is then validated, classified by error type and NCC MERP category, and analysed for contributing factors.

Regardless of the healthcare setting, medication errors data can highlight significant system problems when used and analysed appropriately.

The prescriptions were analyzed for different types of errors. In our study the errors categorized according to NCCMEP classification were reflected as follows. In all of the four years, outcomes of the reported errors were ranging from mild to moderate. We have observed that most of the errors were falling into mild category i.e., B and C corresponding to 43.5%, 44. 7%, 19.8%, 49% & 47.4%, 39.5%, 53.4%, 41.1% for the years of 2020, 2021, 2022 & 2023 respectively. Frequency of B category errors was highest in 2023 (49 %) whereas frequency of C category errors was highest in 2022 (53.4%). Insubstantial number of errors were found to be of moderate category i.e., D, E, F contributing about 6.4%, 6.25%, 9.9%, 3.9% of D errors, 2.5%, 6.25%, 15.8%, 3.9% of E errors and 0%, 2.08%, 0.9%, 1.9% of F errors in the years 2020, 2021, 2022 & 2023 respectively. Apart from only one error falling into G category (1.04%) in the year 2021, no errors were found to be of severe category i.e., G, H and I. From the analysis of collected data we can state that greater percentage of occurred errors were those that had not caused any harm to the patient (B and C). Less significant percentage of errors were those that reached the patient and required either intervention causing temporary or permanent harm, prolonged hospitalization or death (D, E, F, G, H, I).

In our study we have also segregated the errors depending upon the location where they have occurred. We have observed that overall percentage of different types of errors declined from 2020 to 2023. A total of 174 errors were found in Critical care unit and about 377 errors were found to be from In-patient units. In 2020, administration errors were found to be higher (54.3%) in critical care unit. Prescription error were marginally increase in following years for 2020 and 2021 by 6% most likely due to recruitments of fresh batch of residents in ICU for whom proper training and continuous education is being carried out to minimize the errors. The most accountable error in ICU is administration error probably from lack of training.

In IPD unit's incidence of all types of errors were observed to be higher in 2020 with the highest recorded for transcription error (35/140) followed by administration error which was recorded 2nd highest (27/140). Frequency of Transcription error, Prescription error was seen with mild decrease over the years. Indenting error, and Dispensing error was found to be dropping significantly in each year whereas administration error, missed dose and therapeutic duplication errors were decreased initially in 2021 but were found to be raised in 2022. Causes for this is due to nurses didn't check the frequencies of drugs strength of dose, composition, contents in medication, missed dose, cross checking of drugs, and similar brand names these errors were leads to delay in administration and the error was occurred.

As per the study of Aseeri et al, dispensing step of the medication-use process was shown to be the most frequently engaged in reported events,[10] whereas 21 studies in the Middle East report the highest number of MEs during the prescribing process.[11]

Missed dose was increased in year 2022 apprehension is due to nurses were confused regarding the frequencies of 4th hourly and 6th hourly and not knowing the proper doses of the drugs and its indication by these errors were occurred, in order to avoid this continuously teaching, trained and educating nursing staff will helps to minimize the years in further years. Therapeutic duplication was also increased in year 2022 but this does not cause much impact to patients. Further decrease was observed in the following year 2023.

According to Khalili et al., anticoagulant agents were among the most frequently reported drug kinds in ME cases.[12]

Based on the monthly OCRs submitted by the clinical pharmacist provides an entirety on the errors and near misses that has happened in their respective wards. Based on the same, the trainings will be taken on wards to nurses to correct orders or administration plans. Structured education sessions are conducted for residents and nurses on appropriate dosing, scheduling, and the safe handling of high-alert and look-alike/sound-alike medications. This approach is particularly critical in ICUs, where prescribing, transcription, and administration stages are common sources of medication safety incidents, underscoring the importance of focused pharmacist oversight.

The common causes of medication errors are illlegible handwriting, physical or mental exhaustion, patient or coworker interruptions, a lack of pharmacological knowledge, poor performance, missed lab results, long work hours, low self-awareness, insufficient training, and disregard for protocol. Inaccurate dose estimations and a lack of information are commonly associated with these errors. It's important to understand that drug calculating proficiency is a crucial prerequisite for nursing registration and competency evaluation, rather than depending just on strict standards that could stifle critical thinking.

In few countries, has Barcode Medication Administration (BCMA) technology implementation has enhanced patient safety by reducing medication errors through automated verification. By scanning both the medication and the patient's ID wristband, it supports the 'five rights' of medication administration: right patient, medication, dose, route, and time. Hospitals widely adopt BCMA to minimize risks and improve identity verification and accuracy in medication delivery.[9]

Prescription auditing, monitoring, detection and prevention of error is mainly done by clinical pharmacist which has resulted in minimizing the errors in both in-patient as well as in critical care departments. The rapid decrease in errors is because of continuous training by clinical pharmacist to various healthcare givers involved in providing

care to the patient. By continuously exploring their knowledge & by updating others regarding drugs and its uses had helped in reduction of medication errors. The role of Clinical pharmacist is vital in health care sector as they coordinate at various levels of drug delivery thereby giving the maximum coverage possible in tracking and reducing the errors and contributing in improving patient's quality of life.

5. Conclusion

This study underscores the vital contribution of clinical pharmacists in minimizing medication errors within a tertiary and quaternary care hospital over a three-year period. The data reveals a significant decline in error rates, especially in critical care and inpatient settings, demonstrating the effectiveness of clinical pharmacists in identifying errors, auditing prescriptions, and educating healthcare staff. The majority of reported errors were mild, with serious incidents being uncommon. Nonetheless, the study's retrospective design and dependence on voluntary error reporting may result in underreporting and introduce potential bias. Despite these limitations, the results reinforce the essential role of clinical pharmacists in promoting patient safety and highlight the importance of continuous training and oversight in further reducing medication errors. While the complete elimination of such errors may not be feasible, their reduction should remain a key focus for healthcare leadership.

6. Limitations

This retrospective observational study is subject to several limitations. First, underreporting is likely: voluntary incident systems systematically miss near-misses and low-severity or omission errors, vary by cadre and unit, and are sensitive to fear of blame and reporting burden, which can skew error spectra and rates despite efforts to encourage reporting. Second, although concurrent clinical pharmacist Open Chart Reviews (OCRs) increase sensitivity and provide actionable, real-time context, they remain subject to human oversight, time constraints, and inter-rater variability. Finally, as an observational design without randomization, residual confounding and inability to attribute causality persist.

7. Acknowledgement

I would like to sincerely thank Dr. Anisha Merin Varghese and Dr. Chandralekha, clinical pharmacists, for their valuable support in reviewing and contributing data for this research.

7.1. Statement

All authors have read and approved the final version of this manuscript. Each author confirms that they meet the authorship criteria outlined in this document and affirms that the manuscript represents an accurate and honest account of the work conducted.

8. Source of Funding

None.

9. Conflict of Interest

None.

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Cite this article: Patlolla NR, Vidya C, Deepika, Rafi R, Sameem MA, Siddiqua JS, et al. Impact of clinical pharmacist–led medication safety surveillance: A retrospective analysis of prospectively detected errors *Indian J Pharma Pharmacol*. 2025;12(4):240-245.