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Original Article

Centralized Clinical Pharmacy-Drug Order Verifications in Super Speciality Hospitals: Impact on Patient Outcomes and Safety

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ABSTRACT

Introduction: The Centralized Clinical Pharmacy model in multi-branch hospitals plays a pivotal role in enhancing patient safety by minimizing medication errors through the standardization of prescription review and documentation. **Objectives:** To evaluate the effectiveness of the centralized pharmacist oversight in identifying and correcting prescribing issues. **Materials and Methods:** A review of 17,255 prescription checks was conducted to assess the prevalence of medication errors. **Results:** The most common issues identified included therapeutic duplication, incorrect dosing, missing diluent documentation, incorrect scheduling, and incomplete administration details. High-alert medicines and antibiotics were found to carry the greatest risk of errors. **Discussion:** The findings of this review underscore the importance of centralized pharmacist oversight in the early identification and correction of prescribing problems. This oversight supports rational drug use and reinforces medication governance across hospital branches. **Conclusion:** Implementing a centralized clinical pharmacy model significantly contributes to reducing medication errors and enhancing patient safety in multi-branch hospital settings.

Keywords: Centralized Clinical Pharmacy model, High-Alert Medications, Medication Safety, Prescription Audit, Therapeutic Duplication.

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EPIDEMIOLOGY

Clinical Pharmacy Services (CPSs) are an important part of healthcare systems around the world because they help make sure that medications are used safely, effectively, and efficiently. These services include a lot of different things, like improving pharmacotherapy, fixing drug-related problems, and improving patient outcomes through pharmacist-led interventions (Althagafi, 2025).

The most common and avoidable way for patients to get harmed is by making mistakes with their medications. Most of the time, these mistakes happen when the wrong drug or dose is given, the wrong route is used, the wrong way is used, or the wrong patient is given the wrong medication (Oyebode, 2013). The Institute of Medicine (IOM) Committee on Quality of Health Care in the United States defines an "error" as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim (To Err Is Human, 2000). Strategies that focus on common and harmful events like infections, medication mistakes, and pressure ulcers are very useful. Barcode systems and other technological solutions work well to cut down on medication mistakes (Tariq *et al.*, 2024).

A recent report from the World Health Organization (WHO) found that at least 1 in 20 patients (5%) around the world suffer harm from medications that could have been avoided. In 30 studies done in Low- And Middle-Income Countries (LMICs), 7% of people who took medication were harmed. In 70 studies done in High-Income Countries (HICs), 4% of people who took medication were harmed. The African region (9%) and South-East Asia region (9%) had the highest rates of preventable medication-related harm (Global Patient Safety Report 2024, 2024).

REVIEW OF LITERATURE

Centralized clinical pharmacy models in large and multi-branch hospitals seek to standardize medication management and clinical decision-making across various care environments (Gregorová *et al.*, 2017). These models cut down on unnecessary differences in

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pharmacotherapy and encourage consistent practice standards across all branches by putting clinical pharmacists in a central hub that handles formulary management, clinical review of prescriptions, and the creation of evidence-based protocols (Granados *et al.*, 2020; Al and Alnakhli, 2020). In super specialty hospitals, where complex, high-risk therapies are regularly utilised and necessitate close monitoring and dose customisation, this centralised coordination is especially important (Stemer *et al.*, 2012; AlKhanbashi *et al.*, 2024).

Central clinical pharmacy services help to systematically identify and avoid medication-related issues, such as prescription, dispensing, and monitoring errors, from the standpoint of patient safety (Tariq *et al.*, 2024; Rathi *et al.*, 2025). Early error detection and therapy optimisation are made possible by structured procedures such as prospective prescription review, medication reconciliation at care transitions, therapeutic drug monitoring, and drug interaction screening (Granados *et al.*, 2022; Stemer *et al.*, 2012). Clinical pharmacist engagement has been linked to better clinical outcomes, greater adherence to recommendations, and fewer prescription errors and adverse drug events, according to numerous trials and reviews. Hospitals can lower avoidable pharmaceutical harm and improve patient safety throughout all units and branches by including clinical pharmacologists into multidisciplinary processes via the central hub (Rahim, 2026; AlKhanbashi *et al.*, 2024).

Furthermore, centralized clinical pharmacy models frequently include ongoing quality improvement initiatives that support patient outcomes and safety (Gregorová *et al.*, 2017). Healthcare systems can detect system-level vulnerabilities and carry out focused interventions through routine audits of prescribing trends, clinician input, clinical pathway building, and centralized reporting and analysis of pharmaceutical occurrences (Granados *et al.*, 2020). Through these mechanisms, the central clinical pharmacy not only supports individual patient-level interventions but also drives organization-wide improvements in medication safety culture and clinical performance (Al and Alnakhli, 2020).

METHODOLOGY

A six-month (Sep'25-Mar'26) prescription error data of Max Healthcare Ltd., encompassing multi-branch units such as SKT East and West, PPG, GGN, VSH, and SHBG, NAGPUR, to evaluate medication errors identified by the central clinical pharmacy team. Currently for Nagpur unit, an inter-state prescription verification also performed through an online method by CPRS software and Clinical Pharmacy module. It had patient information, the name and dose of the medicine, the name and rate of the diluent, and any corrective or preventive actions that clinical pharmacists had written down.

The clinical pharmacy looked at all prescriptions during this time and put them into groups based on whether they were prescribing, documentation, interaction, or safety-related errors. We used Excel to look at the data and make simple counts and percentages to see how common each type of error was. We also made bar charts to show how the errors were spread out.

RESULTS

Prescription Error Distribution

Critical Prescription Error (Highest Frequency)

Therapeutic Duplication

This is overwhelmingly the largest actual error category. 36.7% (6,339 cases) of No Therapeutic Duplication, suggesting that duplicate therapies are a major systemic issue (Table 1 and Figure 1).

High Alert and Antibiotic Flags

28.1% (4,854) of the medications audited are High Alert Medicines and 17.6% (3,045) are Antibiotics. While not errors in themselves, their high volume coupled with the high error rates in dosing/scheduling increases clinical risk significantly.

Core Prescribing and Documentation Errors

- **Incorrect Dosing:** In 13.2% (2,277) of the audits, the dose was noted as incorrect, making it the most frequent direct prescribing error.
- **Missing Diluent Documentation:** 12.4% (2,142) of the audits found that the required diluent wasn't documented.
- **Scheduling Errors:** In 11.4% (1,970) of cases, the Correct Schedule was marked as "No".
- **Rate of Administration:** The administration rate was missing or incorrectly documented in **7.1%** (1,237) of cases.

Pharmacological and Patient Safety Risks

- **Incorrect Route:** The route of administration was incorrect in 5.8% (1,003 cases).
- **Drug-Drug Interactions:** Significant drug-drug interactions were flagged in roughly 4.9% (853) of instances, and more severe Critical Drug-Drug Interactions occurred in 1.7% (294 instances).
- **Allergies and Contraindications:** Errors involving prescribing allergic drugs (2.3%) or contraindications based on organ function (0.85%) appear less frequently but carry high medical severity.

Antibiotic Error

Out of the 3,045 total antibiotic medications audited, here is the breakdown of the major errors and flags (where the checklist requirement was marked as "No") (Table 2 and Figure 2):

The Most Critical Issue: Therapeutic Duplication

Therapeutic Duplication is by far the most frequent issue. In 39.11% (1,191 cases) of the antibiotic audits, the flag for "No Therapeutic Duplication?" was marked as "No" (indicating that a duplicate therapy *was* present). This is a critical area for intervention given the risks of antibiotic overexposure and resistance.

Core Prescribing Instructions (Dose, Schedule, Instruction) The next largest cluster of errors relates to how the antibiotics are prescribed to be taken:

Incorrect Schedule

Found in 12.2% (372 cases). For antibiotics, strict adherence to timing (e.g., every 8 hr vs. 3 times a day) is critical for maintaining minimum inhibitory concentrations in the blood.

- **Incorrect Dose:** Found in 11.8% (360 cases).
- **Incorrect Instruction:** Found in 10.5% (322 cases).

Safety & Interactions

- **Significant Drug-Drug Interactions:** Noted in 6.9% (211 cases).
- **Incorrect Route:** The route of administration was incorrect in 6.8% (209 cases).
- **Allergic Drugs Prescribed:** Shockingly, in 5.6% (171 cases), the audit flagged that allergic drugs *were* prescribed (i.e., "No allergic drugs prescribed?" was marked "No"). This is a severe patient safety risk.
- **Critical Drug-Drug Interactions:** Flagged in 3.3% (102 cases).

High Alert Medication Error

Out of the 4,854 total high alert medications audited, here is the breakdown of the major errors and flags (where the checklist requirement was marked as "No") (Table 3 and Figure 3).

Documentation of Preparation and Administration (Highest Risk Areas)

- **Diluent NOT Documented:** This is the most severe finding by volume. In a staggering **43.05%** (2,090 cases) of high alert audits, the required diluent was not documented. Since high alert medications often require precise reconstitution, missing diluent details is a massive vulnerability.
- **Rate of Administration NOT Mentioned:** Found in **18.33%** (889 cases). Like diluents, high alert medications (like insulins or continuous infusions) typically require highly specific administration rates.

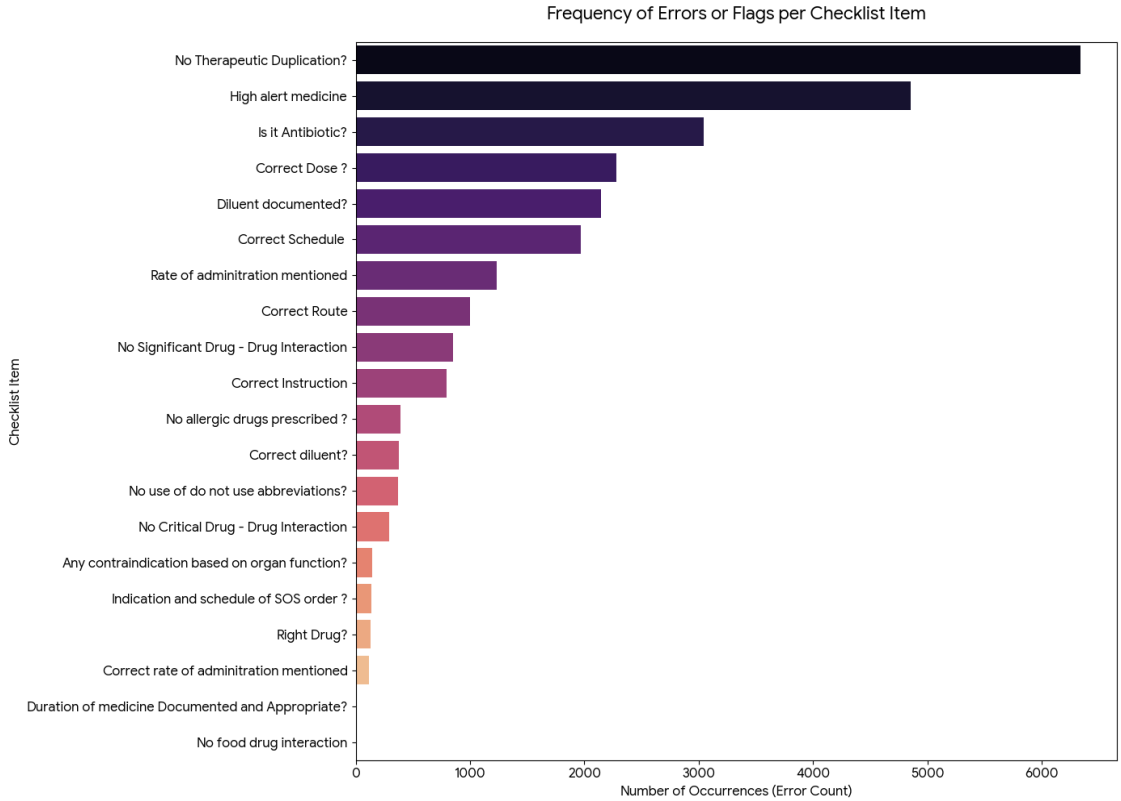

Figure 1: Frequency of Drug Order Verification Errors and Safety Flags Identified during Centralized Clinical Pharmacy Review (*n*=17,255).

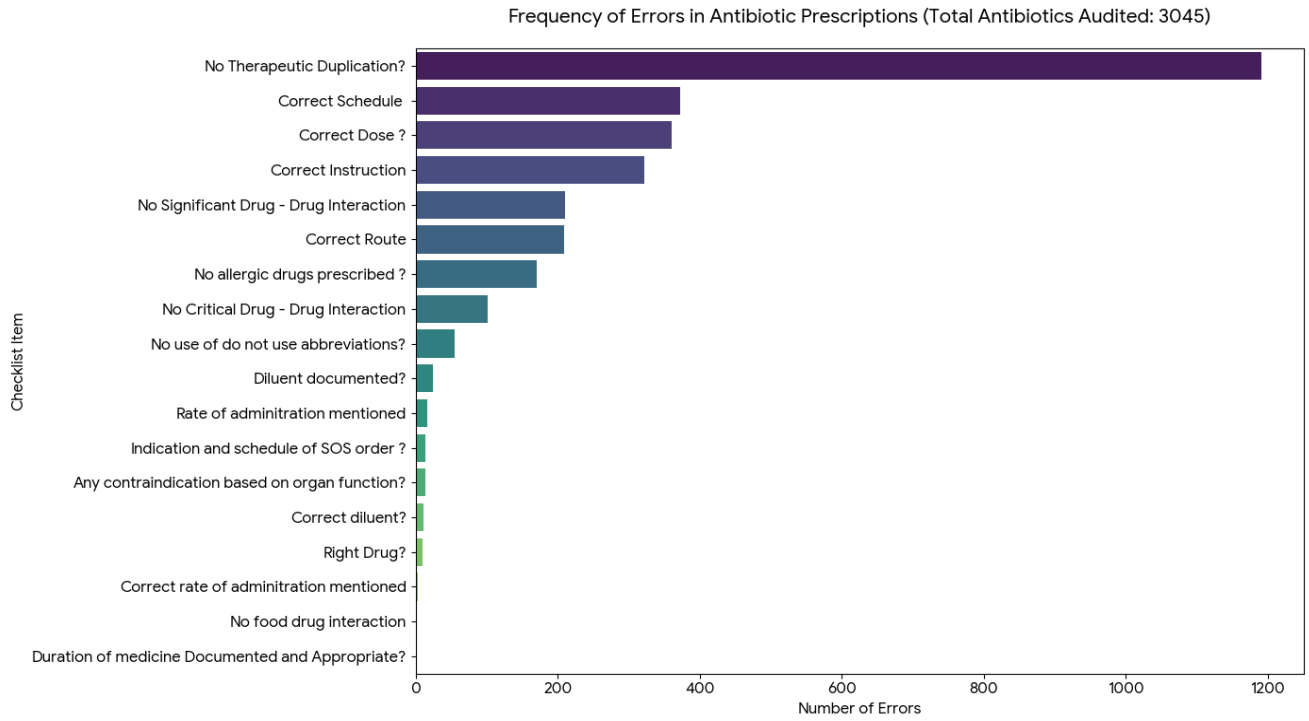

Figure 2: Frequency of Antibiotics Verification Errors and Safety Flags Identified during Centralized Clinical Pharmacy Review (*n*=3045).

Table 1: Distribution of Drug Order Verification Errors Identified by Centralized Clinical Pharmacists (*n*=17,255).

Checklist Item	Error Count	Total Error	Error Rate (%)
No Therapeutic Duplication?	6,339	17,255	36.74%
High alert medicine	4,854	17,255	28.13%
Is it Antibiotic?	3,045	17,255	17.65%
Correct Dose?	2,277	17,255	13.20%
Diluent documented?	2,142	17,255	12.41%
Correct Schedule	1,970	17,255	11.42%
Rate of administration mentioned	1,237	17,255	7.18%
Correct Route	1,003	17,255	5.81%
No Significant Drug - Drug Interaction	853	17,255	4.94%
Correct Instruction	796	17,255	4.61%
No allergic drugs prescribed?	394	17,255	2.28%
Correct diluent?	377	17,255	2.18%
No use of do not use abbreviations?	368	17,255	2.13%
No Critical Drug - Drug Interaction	294	17,255	1.71%
Any contraindication based on organ function?	147	17,255	0.85%
Indication and schedule of SOS order?	140	17,255	0.81%
Right Drug?	128	17,255	0.74%
Correct rate of administration mentioned	114	17,255	0.66%
Duration of medicine Documented...	5	17,255	0.03%
No food drug interaction	4	17,255	0.02%

Table 2: Distribution of Antibiotics related Errors Identified by Centralized Clinical Pharmacists (*n*=3045).

Error / Missing Documentation Type	Error Count	Error Rate (%)
Therapeutic Duplication Present	1,191	39.11%
Incorrect Schedule	372	12.22%
Incorrect Dose	360	11.82%
Incorrect Instruction	322	10.57%
Significant Drug - Drug Interaction	211	6.93%
Incorrect Route	209	6.86%
Allergic drugs prescribed	171	5.62%
Critical Drug - Drug Interaction	102	3.36%
Use of "do not use" abbreviations	55	1.81%
Diluent NOT documented	24	0.79%
Rate of administration NOT mentioned	16	0.53%
Any contraindication based on organ function	14	0.46%
Indication and schedule of SOS order missing	14	0.46%
Incorrect diluent	11	0.36%
Wrong Drug	10	0.33%
Incorrect rate of administration	3	0.10%
Food drug interaction present	2	0.07%
Duration NOT documented and appropriate	2	0.07%

- **Incorrect Diluent Documented:** In **7.19%** (349 cases), the *wrong* diluent was used or prescribed.
- **Incorrect Rate of Administration:** In **2.02%** (98 cases), the rate was mentioned but was incorrect.

Core Prescribing Instructions

- **Incorrect Dose:** Found in 14.54% (706 cases). For high alert medications, slight dosing errors can lead to immediate and severe patient harm.
- **Incorrect Route:** Found in 12.93% (628 cases).
- **Incorrect Schedule:** Found in 3.23% (157 cases).

Pharmacological Risks and Interactions

- **Therapeutic Duplication:** Flagged in 11.94% (580 cases). Having duplicate orders for high alert drugs is extremely dangerous.
- **Drug-Drug Interactions:** Significant interactions were found in 2.28% (111 cases), and critical interactions in **0.70%** (34 cases).
- **Contraindications (Organ Function):** 1.31% (64 cases) were flagged for organ function contraindications.

Critical Drug-Drug Interaction

Across the whole audit, we identified 294 instances of critical drug-drug interactions. The data reveals that a small number of

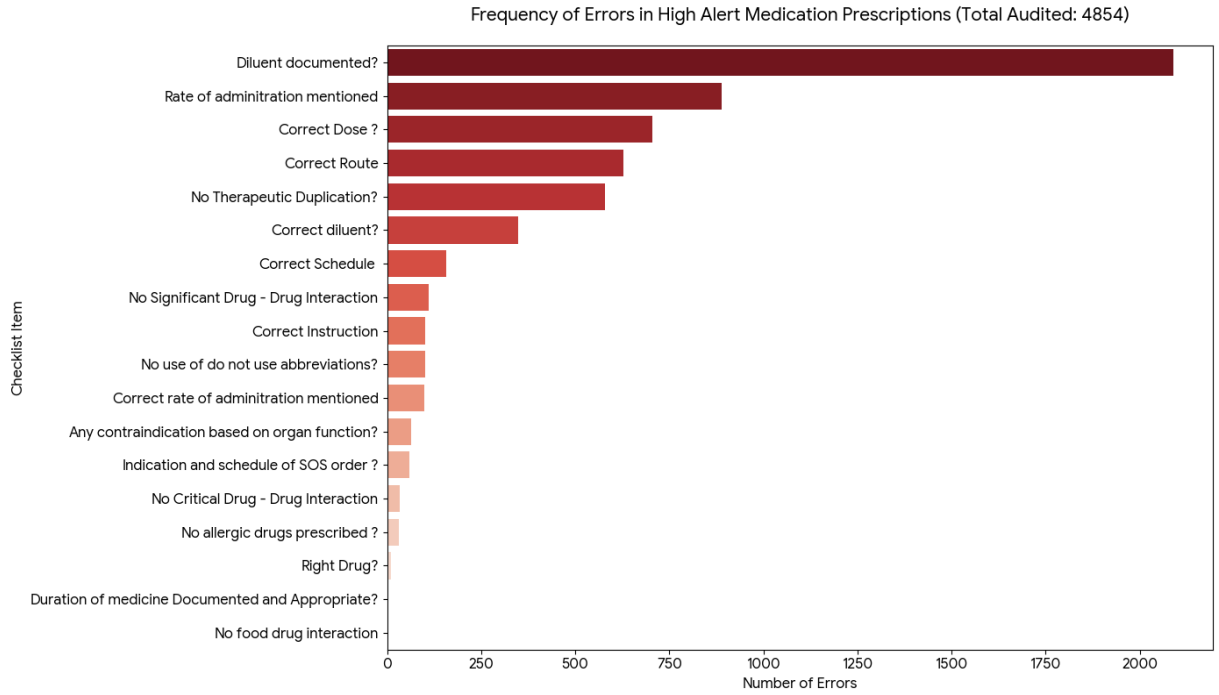

Figure 3: Frequency of High Alert drugs Verification Errors and Safety Flags Identified during Centralized Clinical Pharmacy Review (*n*=4854).

Table 3: Distribution of Errors Identified among High-Alert Medication Orders (*n*= 4,854).

Checklist Item / Error Condition	Error Count	Total Error	Error Rate (%)
Diluent documented? ('No')	2,090	4,854	43.06%
Rate of adminitration mentioned ('No')	889	4,854	18.33%
Correct Dose ? ('No')	706	4,854	14.54%
Correct Route ('No')	628	4,854	12.94%
No Therapeutic Duplication? ('No')	580	4,854	11.95%
Correct diluent? ('No')	349	4,854	7.19%
Correct Schedule ('No')	157	4,854	3.23%
No Significant Drug - Drug Interaction ('No')	111	4,854	2.29%
Correct Instruction ('No')	101	4,854	2.08%
No use of do not use abbreviations? ('No')	101	4,854	2.08%
Correct rate of adminitration mentioned ('No')	98	4,844	2.02%
Any contraindication based on organ function? ('No')	64	4,854	1.32%
Indication and schedule of SOS order ? ('No')	60	4,854	1.24%
No Critical Drug - Drug Interaction ('No')	34	4,854	0.70%
No allergic drugs prescribed ? ('No')	32	4,854	0.66%
Right Drug? ('No')	10	4,854	0.21%
Duration of medicine Documented... ('No')	2	4,854	0.04%
No food drug interaction ('No')	1	4,854	0.02%

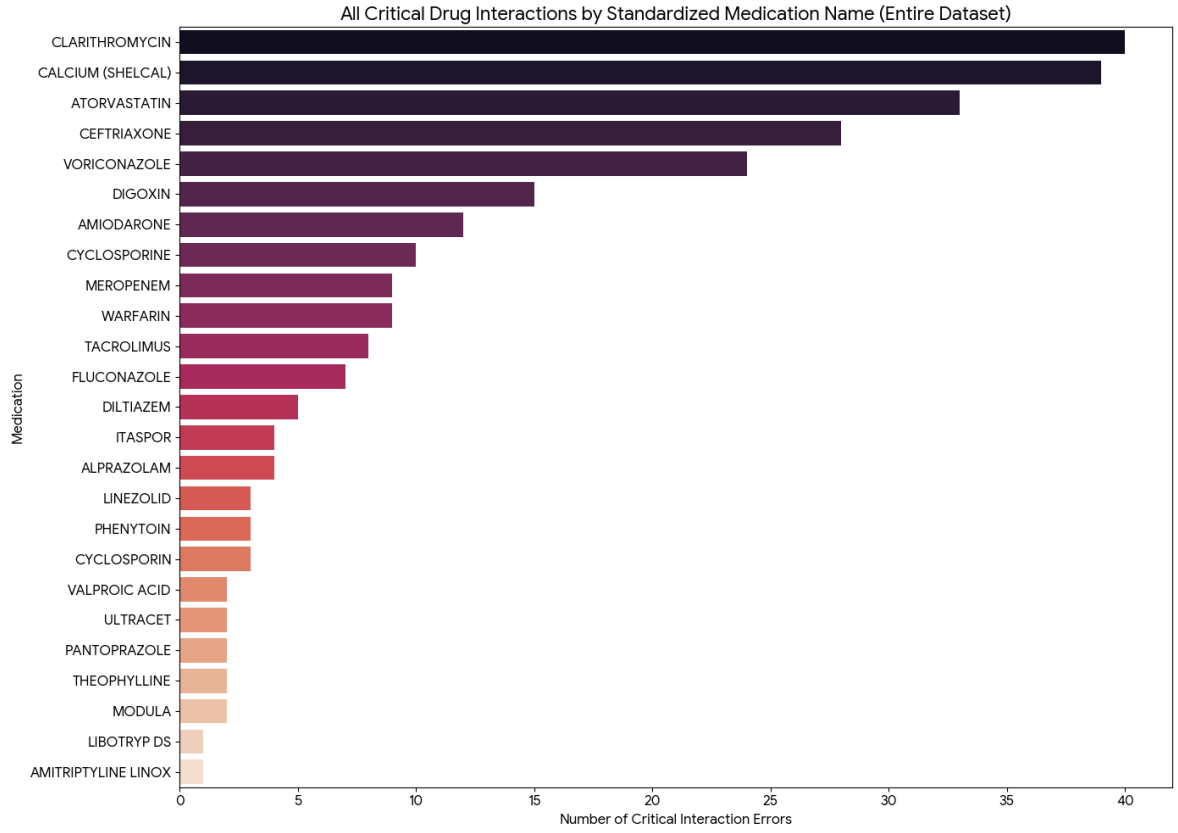

Figure 4: Frequency of Critical drug interactions identified Identified during Centralized Clinical Pharmacy Review (*n*=294).

Table 4: Most Frequently Identified Critical Drug-Drug Interactions during Centralized Clinical Pharmacy Review.

Medication (Standardized)	Critical Interaction Count	Typical Clinical Context
CLARITHROMYCIN	40	Interaction with Statins (Atorvastatin)
CALCIUM (SHELCAL)	39	Interaction with Ceftriaxone (Risk of precipitation)
ATORVASTATIN	33	Interaction with Clarithromycin or Antifungals
CEFTRIAXONE	28	Interaction with Calcium/Shelcal
VORICONAZOLE	24	High-risk antifungal with many metabolic interactions
DIGOXIN	15	Cardiac risk when combined with Amiodarone
AMIODARONE	12	Cardiac risk when combined with Digoxin/ Warfarin
CYCLOSPORINE	10	Interaction with Antifungals/Antibiotics
WARFARIN	9	Bleeding risk with several antibiotics/cardiac meds
MEROPENEM	9	Interaction with Valproic Acid (Seizure risk)
TACROLIMUS	8	Interaction with Diltiazem/Antibiotics
FLUCONAZOLE	7	Interaction with Statins/Ciclosporin

specific medication pairs account for the majority of safety flags (Table 4 and Figure 4).

Key Observations

- **The "Calcium-Ceftriaxone" Cluster:** These two medications appear with high frequency (67 combined flags). This is a critical safety focus because their simultaneous administration can lead to life-threatening particulate matter in the blood.
- **The "Statin-Antibiotic" Conflict:** Clarithromycin and Atorvastatin appear as a dominant pair. This interaction is high-risk for causing rhabdomyolysis (severe muscle breakdown).
- **Narrow Therapeutic Index (NTI) Drugs:** Digoxin, Warfarin, and immunosuppressants (Cyclosporine/ Tacrolimus) show significant interaction counts. For these drugs, even a small interaction can push the patient into a toxic or sub-therapeutic range.
- **Specialty Interactions:** Antifungals like Voriconazole and Fluconazole are frequently involved in critical flags due to their strong inhibition of drug-metabolizing enzymes in the liver.

CONCLUSION

The use of clinical pharmacy module for Centralized Clinical Pharmacy model in multibranch hospitals is essential for enhancing medication safety and facilitating rational prescribing. The audit findings showed that medication-related problems were common, especially therapeutic duplication, wrong dosing, missing diluent documentation, wrong scheduling, and incomplete administration details. This shows that there are big gaps in the quality of prescribing and documentation. High-alert medications and antibiotics were linked to especially high safety risks, such as incomplete preparation instructions, dose-related mistakes, and possible drug interactions, all of which can have a direct effect on patient outcomes.

The results show that having clinical pharmacists review prescriptions in a central location helps find and fix mistakes before they get to the patient, which lowers the risk of harm that could have been avoided. A structured clinical pharmacy system can make medication governance stronger, make practices more consistent across branches, and make it safer to use high-risk drugs. So, adding and integrating centralized clinical pharmacy services should be seen as an important way to make patients safer, get the best possible treatment, and improve the overall quality of care in hospitals with multiple branches.

ACKNOWLEDGEMENT

The authors declare that there are no acknowledgement.

ABBREVIATIONS

CPSs: Clinical Pharmacy Services; **IOM:** Institute of Medicine; **WHO:** World Health Organization; **LMICs:** Low- and Middle-Income Countries; **HICs:** High-Income Countries; **SKT:** Saket; **PPG:** Patparganj; **GGN:** Gurgaon (Gurugram); **VSH**: Vaishali; **SHBG:** Shalimar Bagh; **CPRS:** Clinical Pharmacy Review System; **SOS:** *Si Opus Sit* (if required/as needed); **NTI:**

Narrow Therapeutic Index; **Max Healthcare Ltd.:** Max Healthcare Limited; **Excel:** Microsoft Excel; **Drug–Drug Interaction (DDI):** Interaction between two or more concurrently administered drugs; **High-Alert Medicines (HAMs):** Medications with a heightened risk of causing significant patient harm when used in error.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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