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Impact of Pharmacist Intervention for Drug-Drug Interaction [DDI] Across Various Departments in Multispecialty Hospital - An Observational Study

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Abstract:

- ***Background:***

When 2 or more drugs given together may produces either pharmacokinetic or pharmacodynamic drug-drug interaction at any age.

- ***Aim & Objective:***

The observational study that aimed to assess the prevalence of potential drug-drug interactions (DDIs), identify high-risk departments, evaluate the impact of clinical pharmacist interventions on managing these interactions, and determine the rate of physician acceptance of recommendations in a multi-specialty hospital.

- ***Material & Methods:***

A prospective, observational, and interventional study was conducted over a 6-month period, analysing patient prescriptions across various departments [e.g., cardiology, general medicine, ICU]. Data were assessed using drug databases [e.g., Lexicomp, DrugBank, and Medscape] to classify DDIs based on the severity [Major, Moderate, and Minor].

- ***Results:***

DDI Prevalence: A high prevalence of DDI was observed, with studies reporting that 43.43% to over 78% of patients in hospital settings had at least one potential DDI. Severity & Type: The majority of interactions were moderate in severity. Impact & Interventions: Pharmacists interventions, including dose adjustments, discontinuation of drugs, and alternative therapy recommendations, significantly reduced the risk of adverse drug reaction. Polypharmacy [a greater number of medications] and elderly patients were strongly associated with the higher incidence of DDI.

- ***Conclusion:***

The study concludes that the potential drug-drug interactions are common in multi-specialty hospitals. Timely pharmacist interventions are effective in identifying, preventing, and managing these interactions, that leads to enhancing patient safety, improving quality of care, and reducing the incidence of adverse drug events.

Keywords: *Drug- Drug Interaction, Pharmacists Interventions, Pharmacokinetic, Pharmacodynamic, Polypharmacy, Patient Safety, Clinical Pharmacists.*

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I. INTRODUCTION

Drug–Drug Interactions (DDIs) are defined as a modification in the pharmacological effect of a drug when administered concurrently with another drug, leading to either an increase or decrease in therapeutic efficacy or an increased risk of adverse drug reactions (ADRs) [1]. DDIs are the major cause of preventable medication-related morbidity and mortality, particularly in hospitalized patients who are receiving multiple medications across the various departments of a multispecialty hospital. DDIs are classified as follows: pharmacokinetics, pharmacodynamics, and pharmacological interactions [2].

When one medication changes another drug's absorption, distribution, metabolism, or excretion, this is known as a pharmacokinetic interaction [3]. Omeprazole blocks CYP2C19, which can decrease clopidogrel conversion to its active metabolite, resulting in decreased antiplatelet efficacy and elevated cardiovascular risk [4]. If two medications that have opposing or similar pharmacological effects are taken simultaneously, it causes a pharmacokinetic interaction [5]. Concurrent use of non-steroidal anti-inflammatory drugs (NSAIDS) and hypertensive medications, such as ACE inhibitors or diuretics, is a typical example. This combination can have the "triple whammy" effect of impairing blood pressure control and raising the risk of renal impairment [6].

In this regard, clinical pharmacists are essential for the detection, avoidance, and treatment of DDIs. It has been demonstrated that pharmacist-led interventions, such as medication review, drug interactions screening, and therapeutic drug monitoring, greatly enhance patient safety outcomes and lower the incidence of clinically meaningful DDIs [7, 8]. For pharmacotherapy to be optimized, especially in multispecialty hospital settings, pharmacists must be included in multidisciplinary healthcare teams [9]. By assessing the effects of pharmacists' interventions on drug-drug interactions across multiple departments in a multispecialty hospital, this observational study seeks to emphasize the value of clinical pharmacy services in enhancing medication safety and responsible drug use [10].

The combined use of multiple drugs leads to drug-drug interactions, potentially producing adverse reactions and toxicity or reducing the efficacy of the drug. So, it is essential to monitor the drug-drug interaction to ensure the patient's safety level, particularly in polypharmacy. Particularly in elderly patients receiving polypharmacy, the drug-drug interaction risk is high compared to others.

For example, the diabetic management drugs and cardiovascular drugs increases the risk of drug-drug interaction. Metformin is a commonly prescribed oral hypoglycemic drug that interacts with cimetidine. That interaction between metformin and cimetidine increases the metformin level and lactic acidosis risk [11]. In cardiovascular disease conditions like atrial fibrillation and coronary artery disease, drugs like warfarin and aspirin are administered together. In this combination therapy, aspirin potentiates the anticoagulant property of warfarin, leading to increased bleeding. But this combination therapy is often used in high-risk patients, and it's necessary to monitor the patient closely for signs of increased bleeding and potential complications associated with anticoagulation therapy [12].

During co-administration of theophylline and ciprofloxacin, it produces a significant drug-drug interaction, leading to an increase in the theophylline level and the possibility of toxicity. Here, ciprofloxacin is a fluoroquinolone antibiotic that inhibits the CYP1A2 enzyme responsible for theophylline metabolism. It leads to an elevated level of theophylline concentration and may cause nausea, vomiting, seizures, and cardiac arrhythmias [13].

Drug-drug interaction is an unwanted effect produced when we administer two or more drugs to patients. The concurrent use of multiple drug therapies produces mild to severe types of drug-drug interactions. The interaction from mild interactions to life-threatening or prolonged hospitalization may also cause death. So, healthcare professionals play an important role in ADR monitoring and drug-drug interaction monitoring, in that the pharmacist plays a vital role. It's important to check and prevent the drug-drug interaction by using existing drug-drug interaction data. So, we decided to monitor the drug-drug interaction and prevent the interaction by educating the healthcare professionals about the drug-drug interactions and improving the pharmacists' intervention in drug-drug interactions.

II. METHODOLOGY

- Study design: An Observational Study
- Study period: Three months
- Study site: Sudha Multispeciality Hospital
- Sample size: A total of 180 patients (out of 180 patient case sheets, we identified 170 potential drug-drug interactions) as observed.
- Inclusion Criteria: Patients aged 3 months to 85 years, hospitalized patients from selected departments, patients prescribed more than four drugs, and availability of completed medical records.
- Exclusion Criteria: Coma and surgery patients, patients admitted for less than 24 hrs, and incomplete or inaccessible medical records

- *Method of Identification of Drug-Drug Interactions:*

Drug-drug interactions can be identified by the online sources such as DrugBank [14], Lexicomp [15, 16], and Medscape [17]. Each interaction will be assessed under the two basic needs (i.e.), severity [major, moderate, minor] and mechanism [pharmacodynamic, pharmacokinetic].

- *Data Collection Tool:*

Demographic details of the study population were collected by using a pre-designed observational data collection form to obtain baseline patient information. The following parameters were documented for each enrolled patient. It includes name, IP/Reg no, age, gender, department, diagnosis, and chief complaints. Prescribed medications: All medications prescribed to the patient during hospitalization

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were carefully documented, which includes the drug name, dosage form, dose, frequency, and route of administration. Identified drug-drug interactions may be categorized as pharmacokinetic and pharmacodynamic drug-drug interactions.

* *Outcome Variables:*

Prevalence of the drug-drug interactions, pattern of DDIs across various departments, severity distribution of the identified DDIs, and association between polypharmacy and DDIs.

* *Statistical Analytics:*

The collected data will be entered into Microsoft Excel and analysed. In that percentage value, Graphical representation and pie chart are prepared by interpretation of the collected data. Categorical variables such as DDI severity and department distribution will be expressed as frequency and percentage.

III. RESULTS

From the overall 180 cases, the drug-drug interaction is identified in 170 cases. So, we included only the patients who having that drug-drug interaction in the report's session. The patient without drug-drug interaction cases are omitted from the report and discussion. Because our study focussing the Drug-Drug interactions.

➢ *Gender Based Demographic Analysis:*

The gender-wise distribution of the study population is presented in Table. A total of 170 patients were included in the study, among which 108 (63.53%) were males and 62 (36.47%) were females. The results indicate that male participants constituted the majority of the study population compared to females.

Table 1 Gender Based Demographic Data:

Gender	(N=170)	(%)
Male	108	63.53
Female	62	36.47

➢ *Chronological Profile Analysis of Patients:*

The age-wise distribution of the study participants showed variability across different age groups. Overall, the study population predominantly comprised individuals in the 51–70 years age range, with the highest representation in the 61-70 years group and lowest in the 81-90. Males constituted the majority across most age categories.

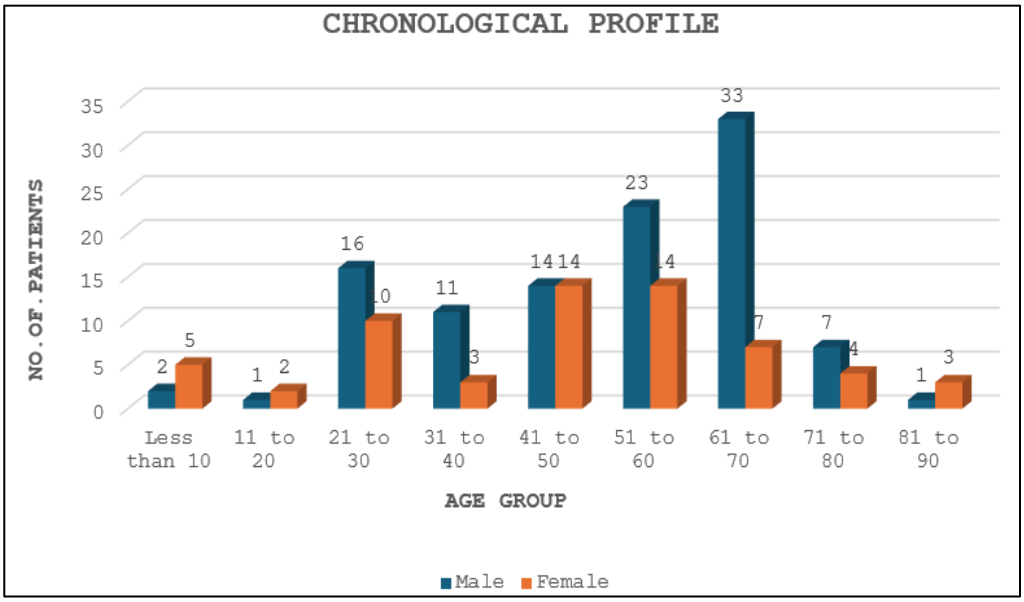

Fig 1 Chronological Profile

➢ *Drug Utilization Pattern Data:*

Table 2 Drug Utilization Pattern Analysis

No. of drugs prescribed	Male	Female	Total	
	(N=108)	(N=62)	(N=170)	(%)
3 to 5	32	12	44	25.88
6 to 8	66	42	108	63.53
9 & above	10	8	18	10.59

The distribution of the number of drugs prescribed among the study participants revealed varying degrees of polypharmacy. Out of the total 170 patients, 44 patients (25.88%) were prescribed 3 to 5 drugs. The majority of patients, 108 (63.53%), received 6 to 8 drugs. A smaller proportion, 18 patients (10.59%), was prescribed 9 or more drugs. The data reflects a considerable prevalence of polypharmacy within the study population.

➢ *Interaction Risk Categorization:*

A total of 287 drug–drug interactions were identified and classified according to severity. Overall, moderate and minor interactions together accounted for the majority of identified drug–drug interactions. Across all severity categories, a higher proportion of interactions was observed among male patients compared to female patients.

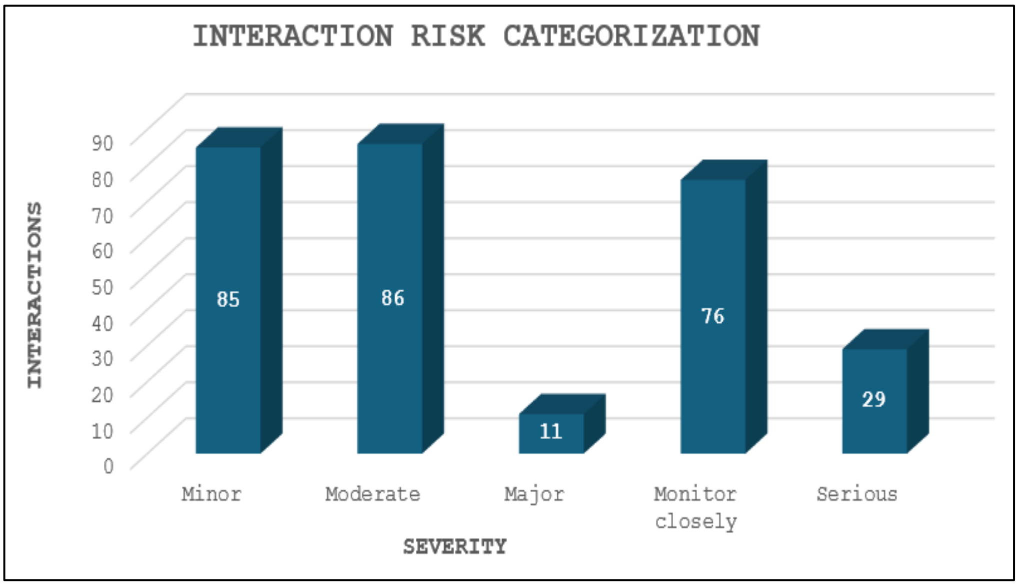

Fig 2 Interaction Risk Categorization Data

➢ *Mode of Interaction Analysis:*

A total of 287 drug–drug interactions were identified and classified based on their mechanism of action. Among these, pharmacodynamic drug interactions were slightly more prevalent, accounting for 152 cases (52.96%). Pharmacokinetic drug interactions constituted 135 cases (47.04%). Thus, pharmacodynamic mechanisms represented the majority of identified interactions in the study population.

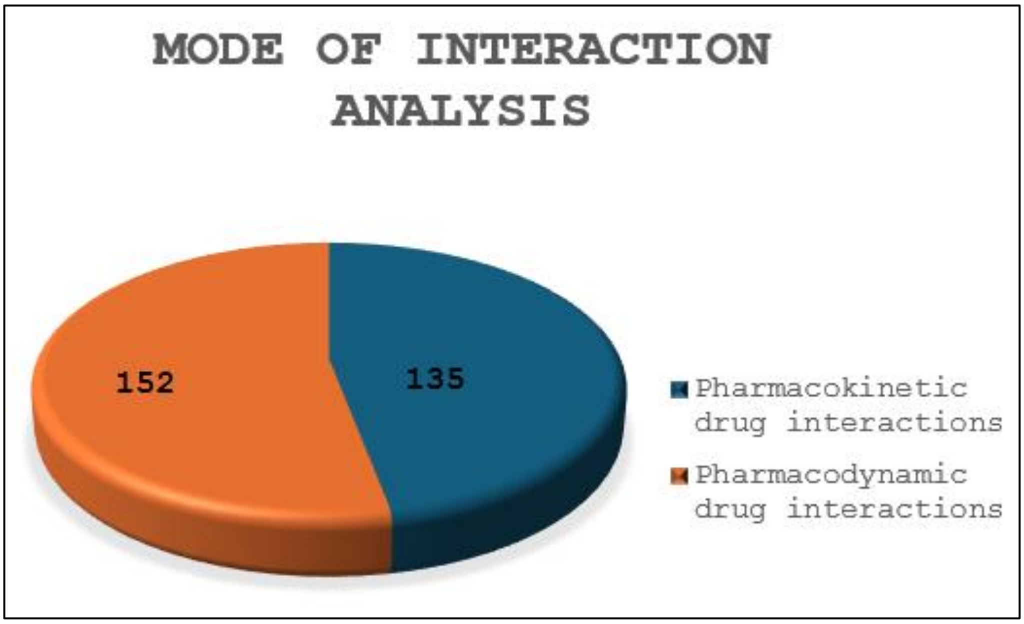

Fig 3 Mode of Interaction Analysis.

➢ *Pharmacokinetic Interaction Assessment Report:*

Out of the 135 pharmacokinetic drug interactions identified, the majority were related to alterations in drug metabolism. Overall, metabolism was the predominant pharmacokinetic mechanism responsible for drug–drug interactions, followed by absorption and excretion, while distribution played a minimal role.

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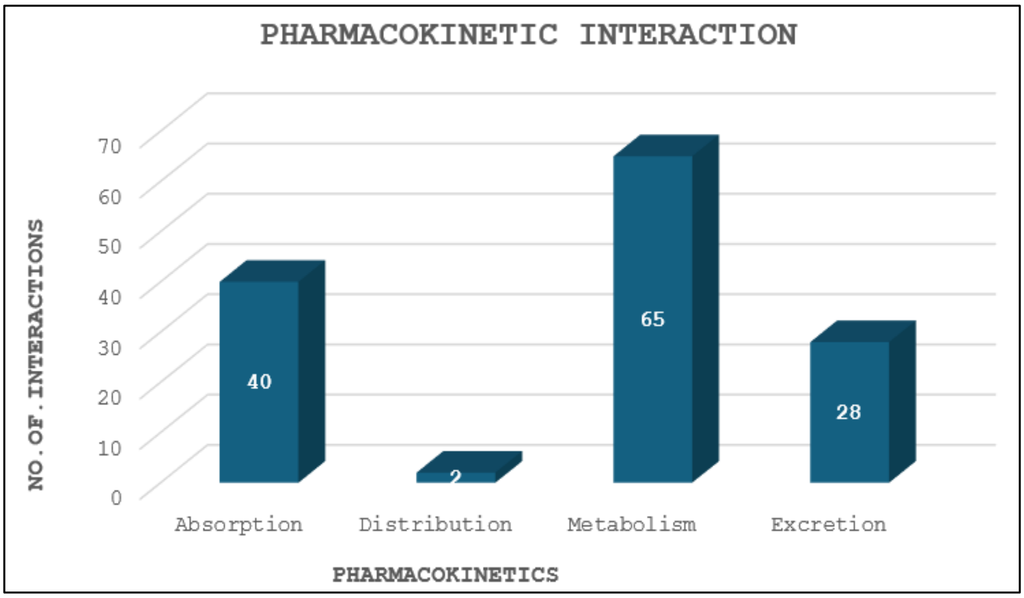

Fig 4 Pharmacokinetic Interaction Assessment.

➢ *Pharmacodynamic Drug Interactions Analysis Data:*

A total of 152 pharmacodynamic drug interactions were identified in the study population. Overall, synergism was the predominant pharmacodynamic mechanism responsible for drug–drug interactions in the study. Additionally, a higher proportion of pharmacodynamic interactions was observed in male patients compared to female patients.

Table 4 Pharmacodynamic Drug Interactions Report

Mechanism of pharmacodynamics	Male		Female		Total	
	(N =)	(%)	(N=)	(%)	(N=)	(%)
Synergism	77	50.66	46	30.26	123	80.92
Antagonism	19	12.50	10	6.58	29	19.08

➢ *Department Wise Distribution:*

The department-wise distribution of study participants is presented in Table. A total of 170 patients were included in the study, comprising 108 males (63.53%) and 62 females (36.47%). The highest number of patients were from the Pulmonology department (33; 19.41%), followed by Gastroenterology (31; 18.24%) and Cardiology (25; 14.71%). The lowest representation was observed in the General Medicine department (2; 1.18%). This distribution indicates that respiratory and gastrointestinal conditions were the most common.

Table 5 Department Wise Distribution

Departments	Male		Female		Total	
	(N=108)	%	(N=62)	%	(N=170)	%
Cardiology	18	10.59	7	4.12	25	14.71
Pulmonology	21	12.35	12	7.06	33	19.41
Neurology	5	2.94	9	5.29	14	8.24
Rheumatology	4	2.35	9	5.29	13	7.65
Gastroenterology	23	13.53	8	0.47	31	18.24
Urology	9	5.29	6	3.53	15	8.82
Endocrinology	5	2.94	5	2.94	10	5.88
Hepatology	4	2.35	0	0.00	4	2.35
General medicine	1	0.59	1	0.59	2	1.18
Nephrology	13	7.65	0	0.00	13	7.65
Others	5	2.94	5	2.94	10	5.88

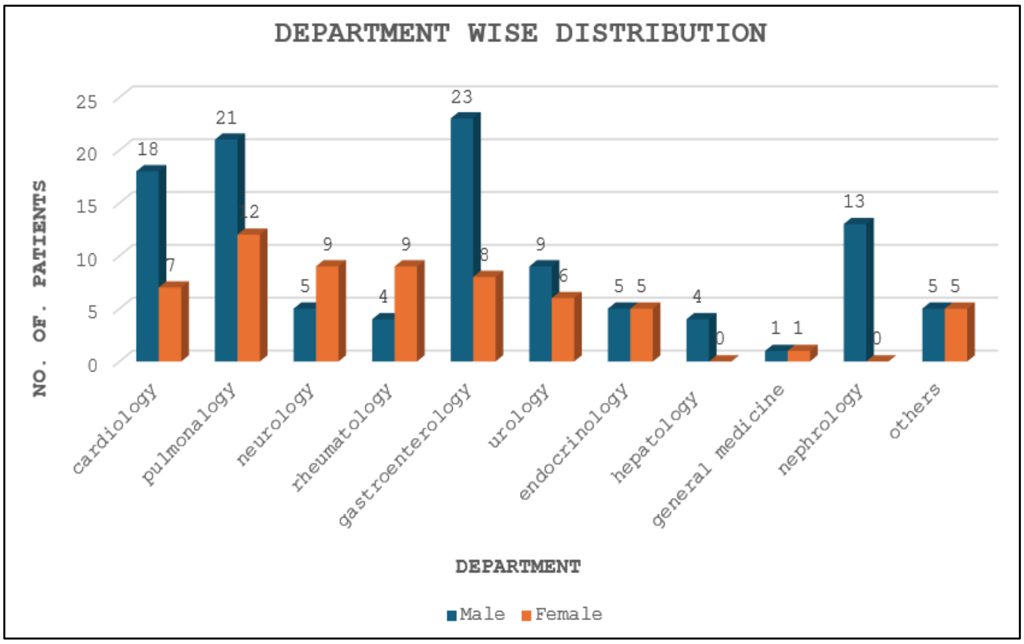

Fig 5 Department Wise Distribution.

IV. DISCUSSIONS

Drug-drug interactions (DDIs) are frequently observed in patients who are prescribed several medications, particularly among elderly individuals and those experiencing polypharmacy. In the present study, pharmacodynamic interactions were found to occur slightly more often than pharmacokinetic interactions and were mainly associated with additive, synergistic, or antagonistic drug effects [18]. Pharmacokinetic interactions were primarily related to modification and drug absorption, biotransformation, and elimination, with interactions involving the cytochrome P450 enzymes being the most commonly noted.

The distribution across departments indicated that the pulmonology department had the highest occurrence of DDIs, followed by gastroenterology and cardiology. Patients between 51-70 years of age were identified as having a greater likelihood of developing drug interactions. Polypharmacy increases the possibility of adverse drug reactions and may compromise therapeutic efficacy. Clinical pharmacists play an important role in the detection and prevention of these interactions through careful medication assessment and monitoring and appropriate dosage modification [19]. In addition, patient education, routine monitoring, and coordination with other healthcare professionals contribute to minimizing the risk of drug interactions and improving patient safety and clinical outcomes [20].

- *Age Distribution and Risk of Drug–Drug Integrations:*

This study demonstrated a higher prevalence of DDIs among patients aged 51–70 years, with the maximum occurrence in the 61–70 years age group. This observation agrees with findings reported by Maher *et al.*, and Katzung, who highlighted that elderly patients are at increased risk of DDIs due to age-related physiological changes, multiple comorbidities, and increased medication burden.

- *Mechanism of Drug–Drug Interactions:*

In the present study, pharmacodynamic interactions (52.96%) were more frequent than pharmacokinetic interactions (47.04%). This finding aligns with studies conducted by Bond and Raehl and Crucio-Souza *et al.*, which reported a predominance of pharmacodynamic interactions in hospitalized patients. Pharmacodynamic interactions commonly arise due to additive, synergistic, or antagonistic effects when multiple drugs are prescribed concurrently, particularly in chronic disease management.

- *Pharmacokinetic Drug –Drug Interactions:*

Among pharmacokinetic interactions identified in this study, metabolism-based interactions were the most common, followed by interactions affecting absorption and excretion. These results are consistent with reports by Stockley and Neuvonen *et al.*, who identified enzyme inhibition and induction as major contributors to clinically significant DDIs. The frequent involvement of metabolism-related interactions highlights the importance of careful selection and monitoring of drugs with narrow therapeutic indices.

The observed absorption-related interactions are comparable to findings reported by Siller-Matula *et al.*, where altered drug absorption significantly affected therapeutic outcomes.

Excretion-related interactions noted in the present study further support findings by Lapi *et al.*, which demonstrated increased risk of renal complications when certain drug combinations are prescribed concurrently.

- *Pharmacodynamic Drug–Drug Interactions:*

The predominance of synergistic interactions over antagonistic interactions observed in this study agrees with

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results reported by Alrawili *et al.*, and Stuhec *et al.*, While synergistic interactions may sometimes be therapeutically desirable, they also increase the risk of adverse drug reactions if not appropriately monitored.

Antagonistic interactions were comparatively less frequent, consistent with findings from Jones *et al.*, who reported lower rates of reduced therapeutic efficacy due to opposing drug effects.

- *Department Wise Distribution of Drug –Drug Interactions:*

Department-wise analysis revealed that the highest number of DDIs occurred in the Pulmonology department, followed by Gastroenterology and Cardiology. Similar patterns were reported by Spandana *et al.*, and Shafiekhani *et al.*, where departments managing chronic and critically ill patients demonstrated higher DDI prevalence due to complex therapeutic regimens. The lower incidence of DDIs in the General Surgery department may be attributed to shorter treatment durations and limited exposure to long-term pharmacotherapy.

V. CONCLUSION

This study Concluded that the pharmacists play an important role in patient care. The involvement helps to decrease drug–drug interactions and increase patients' care and treatment outcomes. to reviewing prescriptions, counselling patients, and working with healthcare teams and pharmacists to ensure safe medication use.

Clinical pharmacists also help to identify and prevent harmful drug interactions with regular prescription review to ensure appropriate interventions. Good communication to doctors improves acceptance of recommendations and promotes rational prescribing. Pharmacist participation was essential in improving safety in medicines and care for patients in hospitals.

FUTURE RECOMMENDATIONS

For future research, we can only get the complete results by including multiple hospitals in the study and increasing the duration of the study. Furthermore, we can improve the medication management by implementing an electronic prescribing system and software. Such methodology is useful for researchers to improve the assessment of the clinical, economic, and long-term impact of pharmacist intervention.

LIMITATIONS

The study was conducted in a single multi-speciality hospital for a limited duration and was based on observational data and prescription review, which may limit the generalizability of the findings and make it difficult to establish a definite cause-and-effect relationship between pharmacist interventions and drug–drug interactions, while patient-related factors such as medication adherence, lifestyle habits, and self-medication were not extensively evaluated.

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