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ORIGINAL PAPER

Role of healthcare professionals in drug-drug interactions and clinical interventions

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ABSTRACT

Introduction and aim. Healthcare professionals including prescribers, pharmacists and nurses must have adequate knowledge of drug-drug interactions because they can cause toxicity, loss of efficacy, and side effects. This study was aimed to assess the respective roles of healthcare professionals in preventing drug-drug interactions by clinical interventions.

Material and methods. This study was conducted at a Secondary Care Hospital of Pakistan in which total 1000 prescriptions were assessed for drug-drug interactions. Questionnaires and descriptive statistics were tools to assess the satisfaction of prescribers with pharmacists and their own prescribed medications before and after the clinical interventions. Modifications in medication therapies were done accordingly after the evaluation and acceptance of interventions.

Results. The p-value was highly significant ($p<0.05$) which showed that the collaboration between healthcare professionals is necessary to avoid drug-drug interaction by clinical interventions. Acceptance rate of interventions was 77%. Clinical interventions are a useful tool in minimizing and preventing drug-drug interactions. The compliance of prescribers with their own prescribed medication regimens increased after clinical interventions.

Conclusion. Prescribers, pharmacists and nurses have their respective roles in preventing drug-drug interactions and they must review the appropriateness of every medication order for clinical interventions.

Keywords. clinical interventions, drug-drug interactions, healthcare professionals

Introduction

Drug-drug interactions are a result of reaction between two or more than two drugs that can lead to the unanticipated side-effects, increase in the effect of a drug, decrease in action of a drug or other potential problems. It is necessary for the prescribers to have the knowledge of drug-drug interactions for the prescribed medications and pharmacists must also review the prescriptions for drug-drug interactions before the medications are dispensed to the patient.[1] Prescribing drugs to the elderly patients carries high chances of drug interactions that can lead to failure in therapy, toxicity or loss of efficacy of drug. Alterations in body physiology, diseases, poly-therapy and homeostasis modify pharmacokinetics as well as responses of drugs as the age progresses. It is essential to periodically evaluate the drug regimens of patients and prescribers must know all the medications taken by patient along-with the herbs and diet.[2] Administration of more than one drug at a time may cause untoward adverse drug reactions due to drug-drug interactions. Poly-therapy accounts for 20-40% drug-drug interactions amongst elders in developed countries. It enhances the complexity in medication management and risk of adverse drugs reactions or reduction in the therapeutic efficacy of medicine. A drug-drug interaction may either be pharmacokinetic or pharmacodynamic.[3] Hence, it is necessary to recognize these drug-drug interactions by clinical knowledge about dif-

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ferent isozymes of cytochrome P450, their inducers, inhibitors and drug transporters. Geriatric pharmacists have suggested de-prescribing in relation to poly-pharmacy to avoid potential drug-drug interactions. It has also been emphasized that the healthcare bodies must promote the preventive strategies for drug-drug interactions among prescribers and pharmacists in the form of databases, drug alerts and periodic health assessments of patients.[4] Potential cytochrome-P (CYP)-mediated drug-drug interactions have high prevalence in older adults with poly-pharmacy and clinical knowledge of pharmacist is the key component for the interventions regarding drug-drug interactions along with drug alert or drug caution software.[5] A study revealed that the efficacy of most frequently prescribed medications at an emergency department of United States was changed due to CYP2D6 drug-drug interactions.[6] Nurses also take caution of drug-drug interactions when they schedule the frequency and time of medication administration and are considered as an important healthcare professional in pharmaco-therapeutic care plan design.[7] Although nurses also have pharmacological knowledge and they serve as the last pillar between the patient and drug-drug interaction but the medication schedules designed by nurses also need a thorough review by prescribers and pharmacists.[8] Hence, the monitoring and management of drug-drug interactions is necessary at all the stages of patient care.

Pharmacists have an importance role in medication safety assurance and prevention of drug-drug interactions. A comparative study of absence and presence of critical care pharmacist during ward rounds showed that the presence of critical care pharmacists for medication review lead to a significant decrease in number of drug-drug interactions and also decreased the length of stay of patients in hospital.[9] Pharmacy information systems cannot completely eliminate the need of pharmacists to prevent potential drug-drug interactions.[10] The incorporation of only clinically relevant drug-drug interactions, color codes and removal of dual entries in clinical decision support software along with the periodic review of all these alerts by team of competent pharmacists can timely catch drug-drug interactions.[11] While prescribing any new medication or making any change in already designed therapeutic regimen, pharmacovigilance is essential which is possible mainly with significant knowledge of drug-drug interactions and secondly by electronic decision support system.[12] The feedback of prescribers is also important while incorporating drug-drug interaction data bases in software because it has an impact on compliance of drug alerts.[13]

In all the healthcare settings where multiple drugs are prescribed or administered to a patient, it is the prime responsibility of the pharmacist to monitor the drug-drug interactions and inform to the physician to avoid toxicity or any untoward effect for patient safety.[14] Pharmacokinetic and pharmacodynamic both the parameters should be evaluated when monitoring drug-drug interactions because both types of drug interactions exist and a special focus must be upon the cardiovascular prescriptions carrying concomitant respiratory medications.[15] A prescribing physician must assess the risk v/s benefit ratio for drug-drug interactions notified by pharmacist along with other biochemical, clinical, pathological and physiological parameters because potential drug-drug interactions are higher in count than the actual drug-drug interactions and risk factors play a vital role in the occurrence of clinically significant adverse effects.[16] The continuous introduction of new drug formulae and already established drug-drug interactions need periodic inclusion as well as updating in clinical decision support systems because although patient safety against drug-drug interactions must be highly focused by pharmacists and prescribers but it is not possible to memorize all existing clinically significant drug-drug interactions.[17] Drug interaction screening software cannot completely replace the need of pharmacists. Drug-drug interaction screening software combined with interventions by pharmacists proved to be the most helpful tools in significant reduction of risk for drug interactions in hospitalized patients.[18]

A study reported that out of 400 patients, potential drug-drug interactions were noticed in the prescriptions of 52.8% patients at two renowned tertiary care hospitals of a province of Pakistan.[19] At a secondary care hospital of Pakistan where this study was conducted, every4 out of 10 patients were previously reported to have drug-drug interactions due to the lack of interventions by healthcare professionals. Software and published data for tracing drug-drug interactions was available at that hospital but the lack of collaboration between prescribers, pharmacists and nurses while prescribing, dispensing or administering the medications leads to the negligence of drug alerts which are important for consideration in patient-centric approach of therapeutic care.

Aim

The aim of this study was to evaluate the respective roles of healthcare professionals including prescribers, pharmacists and nurses in preventing drug-drug interactions by interventions.

Material and methods

Ethics approval

This study was approved by ethics committee of the Secondary Care Hospital of Karachi, Pakistan on August 2021. Healthcare professionals were informed about this study at the hospital. Ethical approval number of

this study is 2021/004 and the ethical principals were followed throughout this study.

Study design

This was an interventional study that was conducted at a Secondary Care Hospital of Pakistan for a period of one year from 2021 to 2022. In this study, the epidemiology of drug-drug interactions, the acceptance of interventions related to drug-drug interactions, their intensities and mechanisms, and the modifications done by healthcare professionals in the medication therapy along with their compliance from the intervened drug-drug interactions for patients were assessed to determine the respective roles of healthcare professionals in preventing drug-drug interactions. The study included inpatients as well as outpatients. Male and female both the genders were included in this study. From total 1000 prescriptions, 690 prescriptions were of female patients and the remaining 310 were of male patients. Verbal consents were obtained from the caretakers of inpatientsand from the ambulatory patients of outpatient clinics. The mean age of patients was 40±20 years. They belonged to the city of Karachi, Pakistan. From the inpatient domain, medication orders from gynecology and obstetrics, general medicine and general surgery were considered for this study while from outpatient domain, psychiatry, neurology, cardiology, general medicine, gastrointestinal and pulmonology clinics. These departments were thought to have most of the drug-drug interactions from IPD and OPD domains and hence the prescribers and nurses from these departments were selected to be the part of this study. All the prescriptions of patients received at pharmacy and other written or verbal medication orders were assessed for drug-drug interactions by qualified registered pharmacists. The pharmacists were trained in hospital pharmacy and had minimum one year of working experience as healthcare professional. Prescribers and nurses of the hospital were also informed by pharmacists about this study.

Data collection

Total 30 prescribers agreed to participate and provided their views for this study. Questionnaires were distributed to those prescribers carrying six questions in them to assess the level of satisfaction of prescribers with pharmacists and with their own prescribed medication regimens before and after the interventions were pointed-out for drug-drug interactions. Prescriptions of all the age groups and genders were included in this study. Total 1000 prescriptions were assessed. Pharmacists and nurses informed prescribers about these drug-drug interactions with their suggestions. The needed steps of modifications in medication therapy were then taken accordingly by prescribers, pharmacists and nursesafter the evaluation and acceptance of those interventions related to drug-drug interactions. The nature of drug-drug interactions and most frequently observed mechanisms of drug-drug interactions were also noted by healthcare professionals.

Statistical analysis

Descriptive statistics were performed to draw the results of this study. Percentages of each identified drug-drug interaction in prescriptions and their acceptance rate were determined. A comparative assessment of the views of prescribers was done through the questionnaires that were distributed to them before and after the interventions of drug-drug interactions by the pharmacists. The intensities and mechanisms of identified drug-drug interactions were also assessed. The modifications that were done in the therapy by the healthcare professionals after acceptance of interventions were also recorded.

Data of this interventional study was statistically analyzed and evaluated through Statistical Package for Social Sciences (SPSS) software 22.0 version (IBM, Armonk, New York, United States). Using Z-test, the difference between the satisfaction of prescribers regarding pharmacists as healthcare professionals in preventing drug-drug interactions and with their own medication therapies before and after the identification of drug-drug interactions by pharmacists and nurseswas compared. SPSS software was used for this purpose. The level of significance was also determined and p value less than 0.05 ($P<0.05$) was considered highly significant.

Results

Table 1 shows that out of total 300 interventions pointed out by pharmacists in 1000 prescriptions, the accepted number of interventions by prescribers were 233. So the acceptance rate of interventions was 77%. Out of accepted 233 interventions, 38 interventions were from inpatient department while 195 interventions were from outpatient department. The most frequently observed drug-drug interaction amongst all was that of gabapentin and tramadol which was prevalent in the psychiatry and neurology clinics of outpatient department. The modification adopted by prescribers for this frequently observed drug-drug interaction was that they prescribed the lowest possible dose of gabapentin and tramadol as per need of the patient. The intermittent interval between the intake of gabapentin and tramadol was kept sufficient. The care-takers and patients were counseled by pharmacist to be vigilant about the respiratory conditions as well as sedation and to immediately report to the prescriber if either of these symptoms is observed. The most accepted intervention was to avoid the prescribed medicine carrying drug-drug interaction and to prescribe any alternate medication for it. As fer-

Table 1. Drug-drug interactions, suggested interventions and proportion of accepted intervention

S No	Drug Interaction	Department	Identified Drug Interactions		Suggested Interventions	Accepted Interventions	
			n = 300	%		n = 233	%
1	Ferrous sulfate decreases levels of levofloxacin by inhibition of gastrointestinal absorption.[20]	Gynecology and Obstetrics (OPD & IPD)	43	14.3	Avoid or Use Alternate Drug	38	88.3
2	Fluoxetine increases carbamazepine levels by hepatic/intestinal enzyme CYP3A4 metabolism.[21]	Psychiatry and Neurology (OPD)	58	19.3	Modify the therapy or monitor plasma levels of carbamazepine	50	86.2
3	Effects of clopidogrel are decreased by omeprazole through hepatic enzyme CYP2C19 metabolism.[22]	Cardiology and General Medicine (OPD)	46	15.3	Use alternative gastroprotective medication with clopidogrel	39	84.7
4	Gabapentin and tramadol have pharmacodynamic synergism and increase effects of each other.[23]	Psychiatry and Neuropathy (OPD)	81	27	Closely monitor the effects if necessary to be given simultaneously	62	76.5
5	Ceftriaxone decreases prothrombin activity of heparin.[24]	General Medicine and General Surgery(IPD)	26	8.7	Use antibiotic of alternative drug class of same coverage with heparin	19	73
6	Fluconazole will increases the effect of alprazolam by hepatic/intestinal enzyme CYP3A4 metabolism.[25]	Psychiatry and General Medicine (OPD)	20	6.7	Dose of alprazolam must be minimum when given with fluconazole	13	65
7	Effects and levels of dexamethasone are potentiated by clarithromycin through P-glycoprotein transporter. [26]	Gastrointestinal and Pulmonology (OPD)	15	5	Avoid their concomitant administration	8	53.3
8	Metronidazole increases the level or effect of simvastatin by hepatic/intestinal enzyme CYP3A4 metabolism. [27]	Cardiology and General Medicine (OPD)	11	3.7	Switch to rosuvastatin if possible as alternative hypolipidemic agent	4	36.3

Table 2. Prescribers' compliance before drug-drug interactions interventions by pharmacists, n (%)

S No	Views of Prescribers	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
1	… carry knowledge about drug-drug interactions	0	5 (16.6%)	13 (43.3%)	10 (33.3%)	2 (6.6%)
2	… feel comfortable in communicating with pharmacists	0	0 (0.0%)	11 (36.6%)	8 (26.6%)	9 (30.0%)
3	…consider pharmacological knowledge of pharmacists	0	5 (16.6%)	10 (33.3%)	5 (16.6%)	10 (33.3%)
4	…consider pharmacists for clinical rounds	0	3 (10.0%)	15 (50.0%)	6 (20.0%)	6 (20.0%)
5	… pharmacists are extremely important for pharmaco-therapeutic care plan	0	10 (33.3%)	12 (40.0%)	8 (26.6%)	0 (0.0%)
6	…perception about role of pharmacists in patient care	0	0 (0.0%)	22 (73.3%)	5 (16.6%)	3 (10.0%)

rous sulfate decreases the gastrointestinal absorption of fluoroquinolone antibiotic and this drug-drug interaction implies to only oral dosage forms of both the agents hence prescriber avoided prescribing any oral medication containing ferrous during the oral antibiotic therapy of levofloxacin. If administration of ferrous was essential for the patient due to low hemoglobin levels, doctor prescribed intravenous iron therapy to such patient during levofloxacin intake period. Nurses were advised to vigilantly monitor such patients while infusing intravenous iron. Pharmacist counseled such patients to avoid intake of products containing iron till the oral levofloxacin therapy completes.

Table 2 revealed a clear change in the views of prescribers for pharmacists as healthcare professionals after the acceptance of their suggested interventions for drug-drug interactions. The p-value calculated for it using Z-test showed high level of significance ($p<0.05$). Medication therapies were modified by healthcare professionals through these interventions and consideration of pharmacists for clinical rounds and designing of pharmaco-therapeutic plans for patient care in collaboration with pharmacists and nurses was emphasized.

67 out of total 300 interventions of drug-drug interactions were not accepted by prescribers. Some of the reasons of their non-acceptance were,

1. Drug-drug interactions were minor or non-significant
2. According to risk v/s benefit ratio assessment, risk was less than benefit of the medication
3. Monitoring parameters for medications carrying drug-drug interactions were already explained by prescriber to the patient or caretaker as there was no other therapeutic equivalent.

Some of the interventions that were not accepted by prescribers are,

1. Phenobarbital decreases the levels of carvedilol by P-glycoprotein efflux transporter
2. Rifampicin decreases the effect of loperamide by MDR1 efflux transporter

Table 3. Prescribers' compliance after drug-drug interactions interventions by pharmacists, n (%)

S No	Views of Prescribers	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
1	… these drug-drug interactions were mostly new to me.	0	7 (23.3%)	1 (3.4%)	17 (56.6%)	5 (16.6%)
2	… made me feel more comfortable in communicating with pharmacists	0	1 (3.3%)	4 (13.3%)	13 (43.3%)	12 (40.0%)
3	… encouraged me to consider pharmacological knowledge of pharmacists	0	2 (6.6%)	2 (6.6%)	7 (23.3%)	19 (63.3%)
4	… encouraged me to consider pharmacists for clinical rounds	0	1 (3.4%)	2 (6.6%)	6 (20.0%)	21 (70.0%)
5	… pharmacists are extremely important for pharmaco-therapeutic care plan	0	3 (10.0%)	6 (20.0%)	17 (56.6%)	4 (13.3%)
6	… improved my perception about role of pharmacists in patient care	0	1 (3.3%)	4 (13.3%)	9 (30.0%)	16 (53.3%)

3. Ciprofloxacin increases half-life and serum levels of duloxetine by CYP1A2 metabolism
4. Ofloxacin and fluvoxamine both increase QT interval.[28]

Table 3 showed that the compliance of prescribers with their prescribed medication regimens increased after suggested interventions for drug-drug interactions.

Table 4 shows that 37% of the modification post intervention was to prescribe alternative medication to possibly avoid drug-drug interaction which was highest amongst all and 35% was that of monitoring the drug effects through periodic lab tests. Complete drug informationsuch as to avoid the simultaneous administration of drugs carrying chances of interaction or to monitor the anticipated effects resulting from any drug-drug interaction was also provided by healthcare professionals to the caretakers of patients. This was also practiced by nurses when they administered medications to the admitted patients.

The serum levels of patients undergoing carbamazepine therapy concomitantly with fluoxetine were repeated after every third, sixth and ninth week of therapy by prescriber and carbamazepine was prescribed in minimum possible dose to avoid its toxic serum levels due to fluoxetine. Omeprazole was replaced by sucralfate as a gastro-protective agent in the prescriptions of patients that were prescribed clopidogrel by prescriber. Patients were counseled to avoid any antacid or other gastro-protective agent of their choice and to inform the prescriber if gastric discomfort occurs. The cephalosporin antibiotic of patients of general surgery carrying heparin in their therapeutic regimen was replaced by amoxicillin infusion because of their almost similar coverage in ear, skin, upper and lower respiratory tract infections while in some cases such as bone or joint infection, clindamycin was prescribed. Other such antibiotics were prescribed as alternative therapy of cephalosporin to the general surgery patients. Bleeding and clotting time of these patients was checked by nurses daily during their hospital stay.Alprazolam was prescribed in the lowest possible dose of 0.5mg/day by the prescriber if administration of fluconazole was essential to the patient. Moreover, pharmacist avoided dispensing extended release tablet of alprazolam to such patients and also counseled them to keep sufficient interval between alprazolam and fluconazole. Prescriber replaced clarithromycin by azithromycin where necessary for patients taking dexamethasone. Similarly, simvastatin was replaced by rosuvastatin in patients taking metronidazole. All the mentioned modifications in the therapy occurred when pharmacist intervened about these drug-drug interactions.

Table 4. Modifications by healthcare professionals (prescribers, pharmacists and nurses) after accepting the interventions, n=233

S No	Modification	N	%
1	Alternative medicine prescribed	96	37
2	Dose adjusted	13	5.5
3	Drug information to attendants	25	10.7
4	Medication review	12	5.1
5	Lab test for monitoring	82	35
6	Dose interval adjusted	10	4.2
7	Dosage form of medicine altered	5	2.2

Figure 1 shows that 55.3% of the identified drug-drug interactions were significant in nature that needed consideration by healthcare professionals due to their intensities.

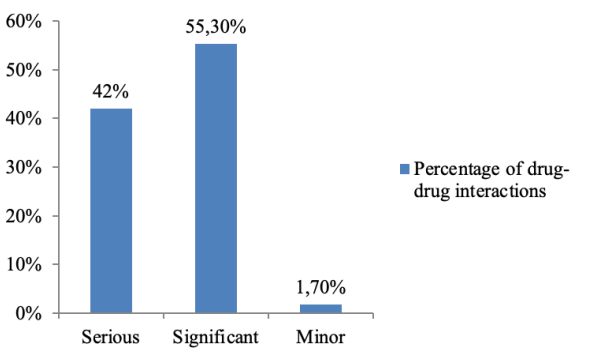

Fig. 1. Intensity and Percentage of drug-drug interactions, n=233

Figure 2 shows that 65.2% of the drug-drug interactions had pharmacokinetic mechanism while others were pharmacodynamic drug-drug interactions.

Reviewing and notifying the drug-drug interactions in the medication orders by pharmacists, vigilant monitoring while administering the medications carrying

drug-drug interactions by nurses and therapeutic modification by prescribers after acceptance of drug-drug interactions are the roles played by these healthcare professionals in preventing drug-drug interactions.

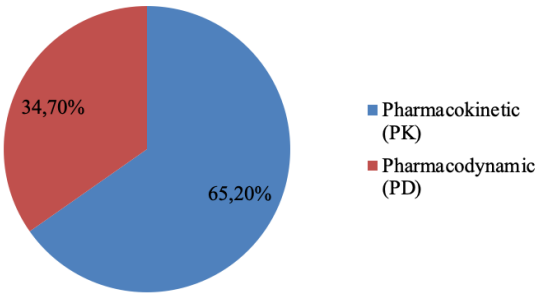

Fig. 2. Mechanism and percentage of drug-drug interactions, n=233

Discussion

Change in the effect of drug when taken together with the other drug is referred to as Drug-drug interaction. This can lead to enhanced or delayed absorption of drug, increased or decreased effect of one or more drugs or may even cause adverse effects on the body. Several efforts have been made till date by healthcare professionals including prescribers, pharmacists and nurses to prevent or possibly reduce the severity of these drug-drug interactions but their complete elimination seems to be impossible to them. It had previously been noted through various researches that the interventions by pharmacists greatly reduced the incidence of clinically relevant drug-drug interactions in a number of patients.[29] Strategic implementation of clinical decision support system at both the prescriptions and administration level can promote the acceptance of drug alerts and clinical interventions of pharmacists.[30] Even though over-the-counter non-steroidal anti-inflammatory drugs are considered safe but the adverse drug reactions from their drug-drug interactions suggest that they must be used in lower doses for short span.[31] It means that the knowledge of pharmacists for drug-drug interactions is compulsory even for the dispensing of over-the-counter medications. Nurses are also important healthcare professionals in preventing drug-drug interactions as they are responsible of safe medication administration as well as monitoring of drug effects at their respective level. An extreme pharmacovigilance is needed for narrow therapeutic index drugs such as anti-cancer therapy because medication assessment for interventions by pharmacologist and hematologist can promote safe use of oncology drugs.[32] A team of healthcare professionals including clinical pharmacist is essential to adjust, manage and monitor the medication therapy for optimized care of patients.[33] Although online tools and drug alert software are important parameters but they cannot completely obliterate the much required collaboration between physicians and pharmacists in minimizing adverse effects resulting from drug-drug interactions because risk versus benefit ratio exists for medications with close monitoring of patients.[34,35] It is also necessary for the healthcare professionals specially clinicians to search drug-drug interaction data bases and medication literatures periodically to remain updated from newly added drug-drug interactions.[36]

This study evaluated the role of healthcare professionals in minimizing drug-drug interactions through interventions and it was done by assessing the prevalence of drug-drug interactions, the acceptance of the related interventions, the intensities as well as mechanisms of the intervened drug-drug interactions, and the modifications done by healthcare professionals after complying from those interventions. The descriptive statistical analysis was done by Statistical Package for Social Sciences (SPSS) software 22.0 version through Z-test on the data of total 300 interventions and questionnaires filled by 30 prescribers at a Secondary Care hospital of Karachi during a period of one year. 22% interventions were rejected by the prescribers due to certain reasons such as, non-significant drug-drug interaction, benefit of the intervened medication was more than its risk, lack of authentic reference or therapeutic equivalent. 49% of the accepted interventions were of the Psychiatry and Neurology clinics of outpatient department. The clinical interventions proved to be a useful tool in minimizing and preventing drug-drug interactions as it sidelined the drug alert fatigue of software faced by prescribers and nurses while entering any medication order.[37] It also reduced the burden of risk versus benefit ratio evaluation by prescribers while prescribing any medication because it added a second step of double check of prescription for drug-drug interactions by pharmacists and a third step of medication assessment by nurses before the medication is administered to the patient.[38] This third step was modified for outpatients by educating them completely for any untoward drug-drug interaction while they take their medications at home.[39] It was revealed by this study that the prevention of drug-drug interactions through interventions carries respective roles of all the healthcare professionals in a healthcare set-up such as, pharmacists reviewed and notified the drug-drug interactions in the received medication orders to the prescribers, nurses vigilantly monitored the administering of medications carrying drug-drug interactions as well as their symptoms and prescribers modified the therapy after acceptance of drug-drug interactions.

88% accepted intervention of any alternative medication or to avoid the prescribed medication by prescriber highlighted the much needed collaboration

between prescribers, pharmacists and nurses to avoid drug-drug interactions for patient-care. The p-value was highly significant ($p<0.05$). The compliance of prescribers for pharmacists and nurses due to their clinical interventions hinted that the pharmaco-therapeutic plan for advanced clinical needs of patients requires knowledge and collaboration between healthcare professionals along with clinical decision support system and drug alerts. 55% of the drug-drug interactions observed in medication orders or prescription were of significant intensities while others were serious or negligibly minor. Out of 233 accepted interventions, 65.2% of them were pharmacokinetic drug-drug interactions while 34.7% were pharmacodynamic drug-drug interactions. 16% of the accepted interventions were from inpatient department while 84% were from outpatient department of the secondary care hospital of Karachi, Pakistan.

The implication of this study underlies the fact that it is necessary for the healthcare professionals, i.e., prescribers, pharmacists, and nurses to collaborate with each other to combat the inclining trend of drug-drug interactions at all the levels of healthcare set-ups.[40] None of these can supersede the domain of the other in this phase of advanced patient care. For example, a prescriber can diagnose and prescribe the therapy efficiently with all the knowledge and cautions for drug-drug interactions but dispensing of medications after review of their intended use, dose, frequency etc is the responsibility of a pharmacist. It is the critical first point where a drug-drug interaction could be intervened. Secondly, the medication monitoring during or after administration as well as their effects are vigilantly recorded by nurses. This is the second critical point for intervention of any drug-drug interaction so that the therapy could be immediately modified. Acceptance or rejection of the interventions is the sole authority of the prescriber in the light of available authentic clinical references or guidelines. The reported number of drug-drug interactions reduced by 30% after this study as the number of drug-drug interactions reduced to 3 out 10 patients in the clinics or departments where this study was conducted. It was because all the healthcare professionals played their respective roles there with collaborative efforts to design appropriate therapeutic care plan for patients. So, it is evident by this study that the healthcare professionals have their respective vital roles in preventing drug-drug interactions and these criteria of drug interventions should be applied at all the healthcare domains.

Conclusion

Healthcare professionals, i.e., prescribers, pharmacists and nurses have their respective vital roles in preventing drug-drug interactions and they must review the appropriateness of every medication order at their respective ends with collaboration to ensure advanced patient-care.

Declarations

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Author contributions

Conceptualization, D.S.; Methodology, D.S.; Software, D.S.; Validation, D.S.; Formal Analysis, D.S.; Investigation, D.S.; Resources, D.S.; Data Curation, D.S.; Writing – Original Draft Preparation, D.S.; Writing – Review & Editing, D.S.; Visualization, D.S.; Supervision, D.S.; Project Administration, D.S.

Conflicts of interest

The author has no conflicts of interest to declare.

Data availability

Data is available on request of the author.

Ethics approval

This study was approved by ethics committee of the Secondary Care Hospital of Karachi, Pakistan on August 2021. Healthcare professionals were informed about this study at the hospital. Ethical approval number of this study is 2021/004 and the ethical principals were followed throughout this study.

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