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The Critical Role of Ward-Based and Satellite Pharmacists in Improving Pharmaceutical Care in Hospital

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Abstract

Background: Medical errors are the third leading cause of death in the U.S., with medication mistakes being a common issue. Medication reconciliation (MR) involves comparing patients' orders with their existing medications to prevent errors. Pharmacists are ideally suited for MR tasks. Effective MR can reduce drug-related rehospitalizations. The aim of this study was to investigate medication errors among hospitalized patients and to evaluate the impact of ward-based and satellite pharmacists on the quality of drug administration services.

Methods: A descriptive cross-sectional study was conducted at Nikan General Hospitals in Tehran, Iran, over a six-month period. We assessed the performance of ward-based and satellite pharmacists in various wards. All patient medication activities were meticulously monitored and recorded. Adjusted Drug-Related Problem (DRP) codes were then used to identify medication errors and the corresponding interventions.

Results: The study included 1,682 patients, each experiencing at least one DRP. The data revealed a DRP prevalence of 6.44% [95%CI: 6.15% to 6.75%]. A total of 2,173 DRPs were identified, with 650 originating from intensive care units and the remaining 1,523 from other wards. Notably, DRPs attributed to nurses (labeled as S2) constituted 18.36%, and those due to drug interactions (classified as D7) accounted for 13.48%. Following intervention, the most common pharmacist recommendations were initiating a medication (14.04%), discontinuing a medication (13.12%), changing a medication (11.38%), and reducing doses (11.09%).

Conclusion: Effective MR, supported by comprehensive training of medical staff such as physicians and nurses, can significantly reduce DRPs in hospitalized patients. Pharmacists play a vital role in this context.

Keywords: Drug-Related Problem (DRP); Medication Reconciliation; Medication Errors; Pharmaceutical Care; Satellite Pharmacist

Abbreviations: MR: Medication reconciliation; DRP: Drug-Related Problem; ASHP: American Society of Health-System Pharmacists; ICU: Intensive Care Unit; OH-ICU: Open-Heart Surgery Intensive Care Unit; CCU: Cardiac Care Unit

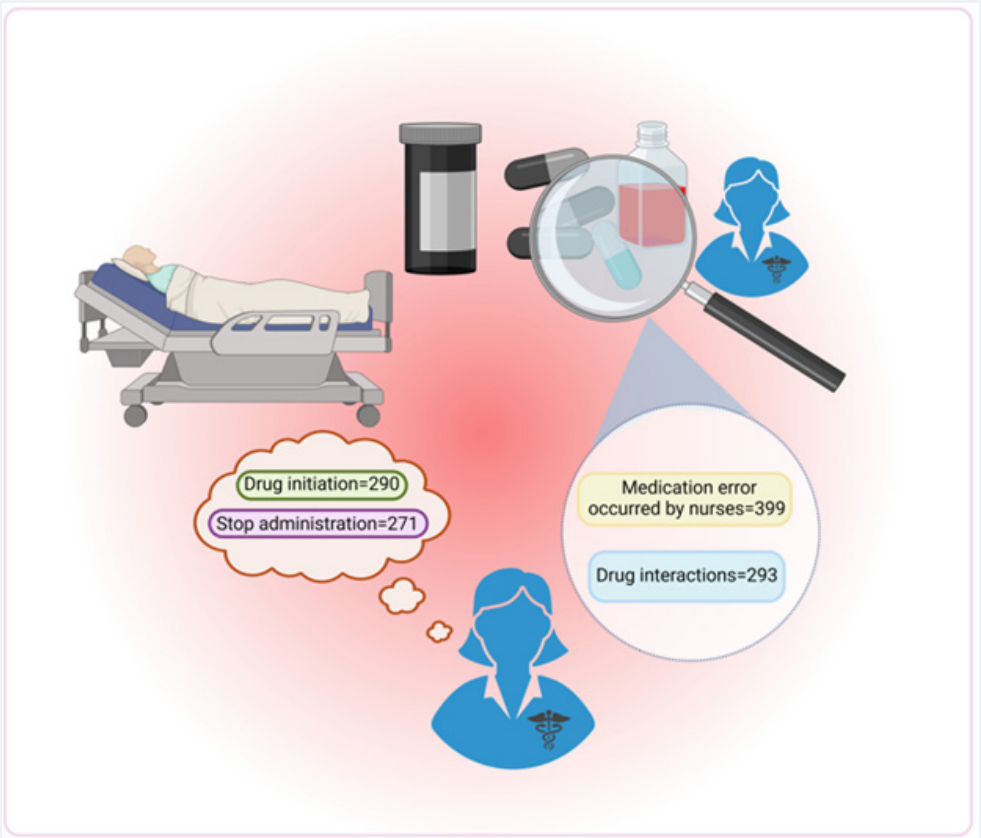
Background

The term "medical error" encompasses any mistake that occurs during diagnosis, treatment, laboratory result analysis, surgery, or medication administration [1]. Medical errors are reported to be the third leading cause of death in the United States, following heart disease and cancer [2]. Additionally, these errors significantly impact the financial burden of the healthcare system [3]. Due to the underreporting of medical errors, their exact statistical incidence cannot be accurately determined in scientific literature [1]. One area where medical errors frequently occur is in the process of medication administration, known as medication error. Medication errors, among the most commonly reported medical errors in the United States, are preventable events that may cause inappropriate medication use or harm to a patient [4,5]. Prescribing medication is a multifaceted process that

demands expertise, sound judgment, and efficient execution from all hospital staff across various units. As previously mentioned, the process of prescribing medications is intricate, involving numerous stages, especially for inpatients. This process requires the participation of several individuals, such as physicians, pharmacists, nurses, and patients [6,7].

Medication errors can occur at any point during the prescribing, transcribing, dispensing, or administering stages [8]. Upon hospital admission, patients may temporarily cease their current medications, introduce new medications, or alter their existing medication regimen. These changes increase the likelihood of medication errors and adverse effects when patients are admitted to or discharged from the hospital [9]. The rise in medication mistakes has heightened public concern regarding healthcare quality. These errors can lead to higher treatment costs, longer hospital stays, and pose risks to the health of hospitalized elderly patients with chronic diseases and children [10]. Studies have shown that medication errors often occur when patients are transferred from one healthcare facility to another. Developing a plan to reconcile medication instructions between these settings is essential to prevent such mistakes [11]. In other words, it is crucial to compare a patient's medication orders with all the medications they have been taking to prevent dosing errors, duplications, omissions, and drug interactions. This process is known as medication reconciliation [12].

The collaborative medication reconciliation process involves all individuals caring for the patient, including the nurse, pharmacist, and physician. Due to its complexity and time-consuming nature, the American Society of Health-System Pharmacists (ASHP) recommends that pharmacists with the necessary expertise implement and sustain effective medication reconciliation procedures in healthcare facilities [13]. Medication reconciliation can be carried out through either paper-based or electronic means. It facilitates access to medication information for those responsible for patient care [14]. The success rate of medication reconciliation can be increased by prioritizing it in hospital policies, ensuring adequate staff training, fostering a collaborative culture, and possessing strong management skills. Studies have shown that effective medication reconciliation can prevent patients' rehospitalization due to adverse drug-related problems (DRP) and their subsequent effects [9,12]. As there is a lack of information on the occurrence of DRPs in Iranian private hospitals, this study was conducted to assess medication errors and the impact of ward-based and satellite pharmacists on the quality of drug administration services for hospitalized patients (Graphical abstract).



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Materials and Methods

Ethical Issues

This study was performed after receiving the code of ethics from the Tehran University of Medical Sciences research ethics committee, Tehran, Iran (code number: IR.TUMS.TIPS.REC.1400.027).

Study Type and Duration

This descriptive cross-sectional study was conducted to evaluate the performance of ward-based and satellite pharmacists in various wards of Nikan General Hospitals (two separate hospitals) in Tehran, Iran, over a six-month period (from March 2020 to September 2020). Clinical pharmacists were stationed as ward-based clinical pharmacists in intensive care units such as the Intensive Care Unit (ICU), the Open-Heart Surgery Intensive Care Unit (ICU-OH), and the Cardiac Care Unit (CCU). In addition, hospital pharmacists (general pharmacists), served either as ward-based pharmacists or as satellite pharmacists in general wards. The study included all patients hospitalized in all wards of Nikan Hospitals. Necessary information was retrospectively collected and entered into pre-designed forms by reviewing the patients' registered documents.

Sample and Procedure

A two-part form was used to collect data. The first part of the form was dedicated to registering patients' demographic information, and the second part was dedicated to registering their medication information. For each patient, all medicinal activities were monitored and recorded in the electronic database for recording DRPs from the time of admission to the time of discharge of the wards. Adjusted DRP codes were used to evaluate medication errors and recommendations (Table 1).

Table 1: DRPs and Recommendations code.

DRP codes			Recommendations code	
Code	**Category**	**Description**	**Code**	**Description**
D1	Drug selection (D)	No indication apparent	**R1**	Dose increase
D2		Unjustified multidrug therapy	**R2**	Dose decrease
D3		Inappropriate dosage form	**R3**	Drug change
D4		Better other drug options apparent	**R4**	Stop administration
D5		Unjustified out of formulary	**R5**	Drug initiation
D6		Possibility of replacing drugs with non-drug therapy	**R6**	Drug formulation change
D7		Drug interaction	**R7**	Drug brand change
D8		Contraindication	**R8**	Dose frequency/schedule change
D0		Other drug-related problems	**R9**	Other changes to therapy
O1	Overdose/Underdose (O)	Prescribed dose too high	**R10**	Refer to other prescribers
O2		Prescribed dose too low	**R11**	Refer to outpatient clinic/Pharmacotherapy clinic
O3		Long duration of drug therapy	**R12**	Refer to other hospital
O4		Short duration of drug therapy	**R13**	Patient education about therapy, drugs, and disease
O0		Other dose problems	**R14**	Written summary of medications
C1	Patient compliance (C)	Intentional drug overdose	**R15**	Recommend diet/lifestyle modification
C2		Intentional drug underdose	**R16**	Other education about patient's drug
C3		Arbitrary use of medicine without a doctor's prescription	**R17**	Monitoring: laboratory data
C4		Difficulty using dosage form	**R18**	Monitoring: non-laboratory
C0		Other patient compliance problems	**R19**	Other recommendations
U1	Undertreated (U)	Inadequate treatment regimen		
U2		Not starting treatment		
U3		Preventative therapy treatment		
U0		Other untreated indication problems		

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M1	Monitoring (M)	Laboratory monitoring required		
M2		Non-laboratory monitoring required		
M0		Other monitoring problems		
E1	Education or information (E)	Patient requests drug information		
E2		Patient requests disease management advice		
E3		Patient requests alternative treatment options information		
E4		Patient request drug brand/generic name information		
E0		Other information or education problems		
N	Other (N)	Other problems		
T1	Drug toxicity (T)	Adverse drug reaction		
T0		Other drug safety problems		
S1	Medication error (S)	Occurrence of any medication error by patient		
S2		Occurrence of any medication error by nurse		
S3		Occurrence of any medication error by physician		
S4		Wrong request/record of drug in system		
S5		Wrong patient admission by nurse		
S6		Drug list writing errors by nurse		
S7		Drug administration error by nurse		
S8		Wrong patient drug box by nurse		
S9		Wrong tele-prescription by nurse		
S10		Pharmacy technician error		
S11		Other medical staff error		

Statistical Analysis

The frequency of DRPs and their contributing factors were analyzed using Office Excel 2019 and SPSS version 22 software. Descriptive statistics, including means and percentages, were used to present the results.

Results

Patient characteristics

Of the 26,111 hospitalized patients analyzed for Drug-Related Problems (DRPs), 1,682 patients with at least one DRP were included in this study. The majority of these patients were hospitalized in the Cardiac Care Unit (CCU), General Surgery, Obstetrics and Gynecology, and Intensive Care Units (ICU), with 304 (18.1%), 285 (16.9%), 231 (13.7%), and 225 (13.4%) patients respectively (Table 2). The patients' mean age (±SD) was 57.10 (±19.01) years. Among them, 56.9% were female (957 patients), and 43.1% were male (725 patients). The study involved the prescription of a total of 1,674 drugs to patients, with an average of 9.48 (±5.157) drugs per patient. The frequency of underlying comorbidities is summarized in Table 3. The most commonly observed underlying diseases among the patients were hypertension, cardiovascular and coronary heart diseases, diabetes, and hyperlipidemia, in that order.

DRPs frequency

It was found that the prevalence of Drug-Related Problems (DRPs) among patients was 6.44% [95%CI: 6.15% to 6.75%]. All observed DRPs in patients are summarized in Figure 1. A total of 2,173 DRPs were detected, with 650 occurring in intensive care units (ICU, CCU, and ICU-OH) and 1,523 in other wards. In reviewing DRPs related to drug selection (D), drug interactions (D7), contraindications (D8), and unjustified multidrug therapy (D2) were the most frequently observed DRPs, with 293 (13.48%), 139 (6.4%), and 116 (5.34%) cases, respectively. Regarding over/under dosing in the medication group (O), in 167 cases (7.68%),

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the prescribed medication dose was too high (O1), and in 39 cases (1.79%), it was too low (O2). In the patient compliance section (C), intentional drug overdoses (C1) [43 cases (1.98%)] and intentional drug underdoses (C2) [23 cases (1.06%)] were the most frequently observed DRPs after other patient compliance problems (C0) [60 cases (2.76%)].In the under-treatment section (U), an inadequate treatment regimen (U1) was the most observed DRP, with 107 cases (4.92%). Additionally, in 65 cases (2.99%), the required treatment had not been initiated (U2), and 71 patients (3.27%) required preventive medication that had not been started (U3). Generally, the highest frequency of observed DRP was related to the medication errors section (S), with 399 errors (18.36%) caused by nurses (S2).

Table 2: Frequency of each ward DRPs.

Ward	Frequency	Percentage (%)
obstetrics and gynecology	231	13.7
Internal medicine	193	11.5
General surgery	285	16.9
Orthopedy	103	6.1
Urology	94	5.6
Cardiology	176	10.5
Oncology	14	0.8
Pediatrics	18	1.1
Neurology	21	1.2
Neurosurgery	11	0.7
Oral and Maxillofacial Surgery	7	0.4
CCU*	304	18.1
ICUs#	225	13.4
Total	1682	100

*CCU= cardiac care unit; #ICU=Intensive care unit

Table 3: The most frequent comorbidities.

Underlying comorbidities	Number of cases	Percentage (%)
Hypertension	827	49.17
Hyperlipidemia	379	22.53
Diabetes mellites	417	24.79
Renal disease	126	7.49
Respiratory disease	17	1.01
Mental and psychiatric disorders	73	4.34
Thyroid dysfunction	49	2.91
Benign prostatic hyperplasia	30	1.78
Cardiovascular and coronary artery disease	478	28.42
Malignancies	17	1.01
Anemia	9	0.53
Surgical history	170	10.11
Cataract	9	0.53
Allergies	62	3.69
Addiction	35	2.08
Autoimmune disorders	11	0.65

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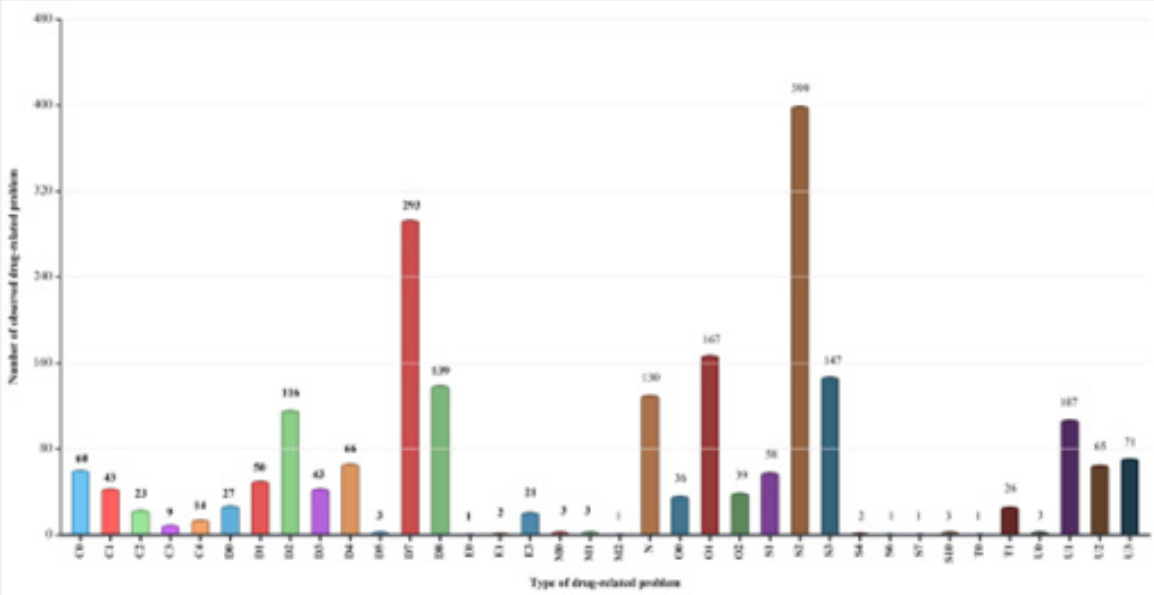

Figure 1: Drug-related problems (DRPs) frequencies.

D0=Other drug-related problems; D1=No indication apparent; D2=Unjustified multidrug therapy; D3=Inappropriate dosage form; D4=Better other drug options apparent; D5=Unjustified out of formulary; D7=Drug interaction; D8=Contraindication; O0=Other dose problems; O1=Prescribed dose too high; O2=Prescribed dose too low; C0=Other patient compliance problems; C1=Intentional drug overdose; C2=Intentional drug underdose; C3=Arbitrary use of medicine without a doctor's prescription; C4=Difficulty using dosage form; U0=Other untreated indication problems; U1=Inadequate treatment regimen; U2=Not starting treatment; U3=Preventative therapy treatment; M0=Other monitoring problems; M1=Laboratory monitoring required; M2=Non-laboratory monitoring required; E0=Other information or education problems; E1=Patient requests drug information; E3=Patient requests alternative treatment options information; N=Other problems; T0=Other drug safety problems; T1=Adverse drug reaction; S1=Occurrence of any medication error by patient; S2=Occurrence of any medication error by nurse; S3=Occurrence of any medication error by physician; S4=Wrong request/record of drug in system; S6=Drug list writing errors by nurse; S7=Drug administration error by nurse; S10=Pharmacy technician error.'

In this study, interventions and recommendations made by pharmacists were also evaluated, as summarized in Figure 2. Regarding implemented recommendations, 290 cases (14.04%) were advised to start a medication (R5), 271 cases (13.12%) to stop prescribing a drug (R4), 235 cases (11.38%) to change the medication (R3), and 229 cases (11.09%) to reduce the medication dose (R2). Also, other recommendations not fitting the above categories (R19) were more frequently observed after R5 and R4, with 244 cases (11.82%). Additionally, DRP categories such as D6 (possibility of replacing drugs with non-drug therapy), E2 (patient requests disease management advice), E4 (patient requests drug brand/generic name information), O3 (long duration of drug therapy), O4 (short duration of drug therapy), S5 (wrong patient admission by nurse), S8 (wrong patient drug box by nurse), S9 (wrong tele-prescription by nurse), and S11 (other medical staff error) did not occur in this study. Furthermore, among the recommendations provided by ward-based and satellite pharmacists, 474 recommendations (28.2%) were accepted by the physicians, 774 recommendations (46%) were managed by the pharmacists, and 68 recommendations (4%) were rejected by the physicians. In 366 cases (21.8%), the physician was contacted but did not respond, so the pharmacists addressed the issue using their professional judgment.

Comparison of occurred DRPs between the intensive care units and the other wards

Regarding the comparison of occurred DRPs between the intensive care units (ICU, CCU, and ICU-OH) and the other wards we observed that the most occurred DRPs in the intensive care units were S2, D7, and S3, respectively [196 (30.15%), 87 (13.41%), and 54 (8.31%)]. In contrast, D7, S2, O1, and D8 were the most observed DRPs in the other wards, respectively [206 (13.53%), 203 (13.33%), 138 (9.06%), and 130 (8.54)]. Regardless of the DRPs mentioned above, C4 (difficulty using dosage form), U0 (other untreated indication problems), E0 (other information or education problems), E1 (patient requests drug information), T0 (other drug safety problems), and S7 (drug administration error by nurse) non occurred in ICUs. Data are summarized in Figure 3.

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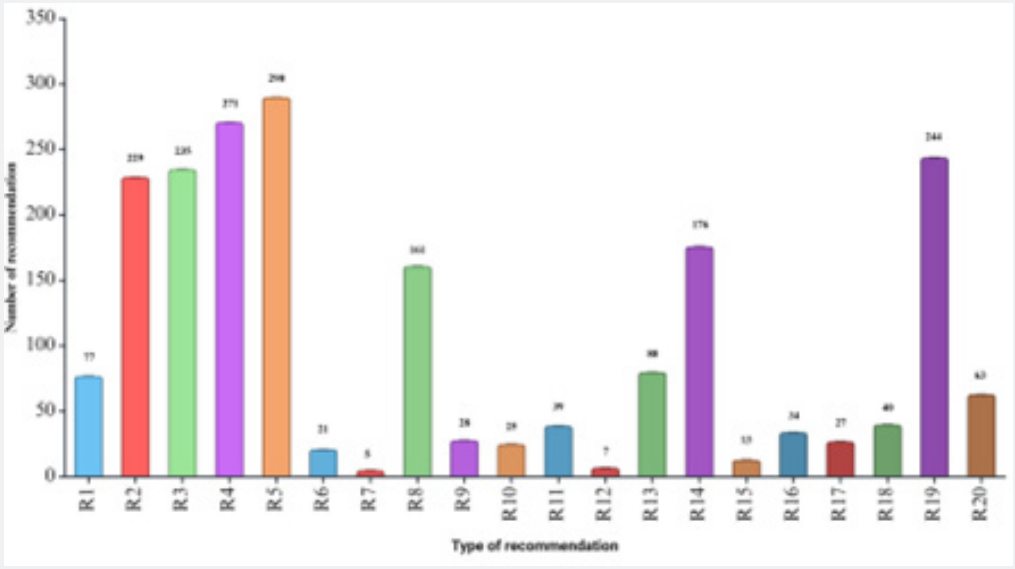

igure 2: Recommendations frequencies.

R1=Dose increase; R2=Dose decrease; R3=Drug change; R4=Stop administration; R5=Drug initiation; R6=Drug formulation change; R7=Drug brand change; R8=Dose frequency/schedule change; R9=Other changes to therapy; R10=Refer to other prescribers; R11=Refer to outpatient clinic/Pharmacotherapy clinic; R12=Refer to other hospital; R13=Patient education about therapy, drugs, and disease; R14=Written summary of medications; R15=Recommend diet/lifestyle modification; R16=Other education about patient's drug; R17=Monitoring: laboratory data; R18=Monitoring: non-laboratory; R19=Other recommendations; R20=No intervention.

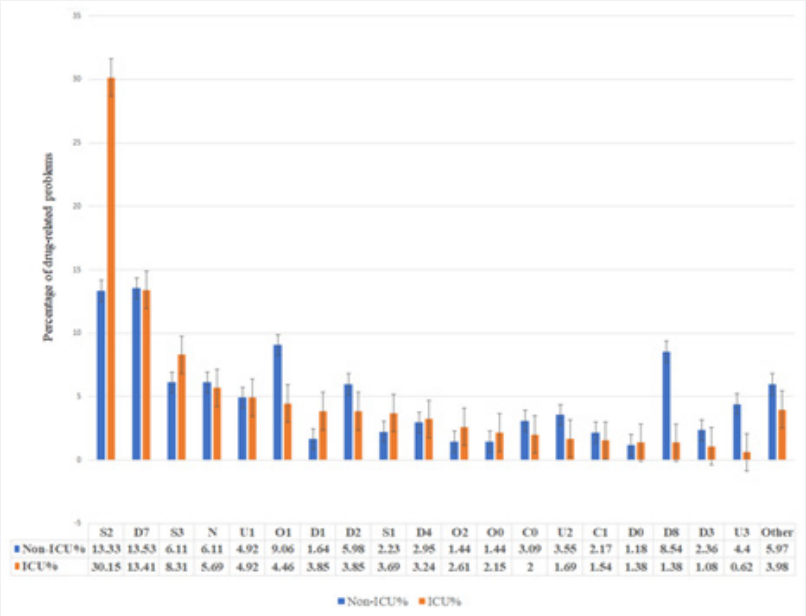

Figure 3: Comparison of occurred DRPs between the intensive care units and the other wards.

D0=Other drug-related problems; D1=No indication apparent; D2=Unjustified multidrug therapy; D3=Inappropriate dosage form; D4=Better other drug options apparent; D7=Drug interaction; D8=Contraindication; O0=Other dose problems; O1=Prescribed dose too high; O2=Prescribed dose too low; C0=Other patient compliance problems; C1=Intentional drug overdose; U1=Inadequate treatment regimen; U2=Not starting treatment; U3=Preventative therapy treatment; N=Other problems; S1=Occurrence of any medication error by patient; S2=Occurrence of any medication error by nurse; S3=Occurrence of any medication error by physician.

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Discussion

The primary aim of this study was to evaluate medication errors and the impact of ward-based and satellite pharmacists on the quality of drug administration services and pharmaceutical care for hospitalized patients. To our knowledge, this was the first study to assess the occurrence of Drug-Related Problems (DRPs) in two Iranian private hospitals. Our results indicate that the prevalence of DRPs among patients was 6.44% [95%CI: 6.15% to 6.75%], with the majority being S2 (DRPs caused by nurses) and D7 (drug interactions). Pharmacists play a crucial role in identifying these DRPs, suggesting that the presence of ward-based and satellite pharmacists can help prevent these DRPs during patients' hospitalization. Early identification of DRPs can reduce the length of hospitalization, its associated costs, and related problems. Our study underscores the significant role of ward-based and satellite pharmacists in optimizing patients' treatment processes, reducing DRPs and their subsequent complications, thereby decreasing hospital stays and costs to patients and insurance companies, particularly in patients with chronic diseases [14,15]. With the expansion of pharmacists' roles over the past decade, moving from traditional inpatient pharmacy duties to providing clinical services in hospital wards, their interaction with other healthcare providers has increased. This has led to reduced DRPs and healthcare costs [16]. Our study found that pharmacists managed nearly 6.5% of the identified DRPs, identifying and resolving critical DRPs such as drug interactions before orders were executed and registered in the system. This underscores the importance of investment in this area, even for private hospitals, as medication errors can be prevented before prescribing.

Addressing and preventing these errors is crucial, as each error can lead to serious consequences. Some studies also demonstrated the important roles of pharmacists in hospitals. In this regard a review study by Viktil et al. showed that clinical pharmacists in hospitals lead to better treatment outcomes [17]. Georg et al. conducted a study in a Malaysian public hospital, demonstrating that increasing the number of pharmacists in each ward and reviewing patients' drug lists at discharge increased the detection of DRPs, leading to necessary measures to prevent these DRPs and the resulting costs to patients [18]. Moreover, Viktil et al. found that patients consulted by pharmacists had more DRPs than others in their study across seven hospital wards in Norway [19]. They observed that the need for additional medication, errors in medical charts, patient compliance, and the requirement for patient education were the most frequent observed DRPs in their study. In our study also the most frequent recommendation was the needs for drug initiation (R5=290 cases). Babelghaith et al. conducted a study in a Saudi hospital, finding that the most common DRP was significant drug interactions (49%) [20]. We also observed that D7 (drug interaction) is the second most frequently observed DRP after S2 (DRPs caused by nurses). Zargarzadeh et al. investigated medication reconciliation at the Al-Zahra Medical Center of Isfahan, Iran, finding a high rate of medication discrepancies [21].

Studies have shown a high risk of DRPs, especially major drug-drug interactions, in patients with polypharmacy, such as geriatrics or ICU-admitted patients [22-24]. In our study, the two most common DRPs were those caused by nurses (S2) and drug interactions (D7). Using reliable databases, ward-based and satellite pharmacists can prevent these DRPs through a complete review of patients' prescribed drug lists, especially in patients with polypharmacy [24]. In conclusion, the constant presence of ward-based and satellite pharmacists in hospital wards and their closer interaction with prescribers can help reduce DRPs and the treatment costs following their complications [25,26]. Additionally, with the high frequency of S2 (DRPs caused by nurses), ward-based and satellite pharmacists, through good medication reconciliation programs and training classes for healthcare providers, especially nurses in ICU wards, can reduce the incidence of medication errors and consequent side effects. The limitations of our study include the lack of access to the total number of hospitalized patients in each ward, preventing a detailed statistical analysis, and the lack of cooperation from physicians and other medical staff. Since this study was retrospective, future prospective studies could better investigate the effects of ward-based and satellite pharmacists on DRPs and treatment cost reduction.

Conclusion

Finally, the results of this study showed that ward-based and satellite pharmacists have an influential role in detecting DRPs occurring in hospitals and hindering their consequent side effects, resulting in a lower financial burden on patients and hospitals. The implementation of appropriate and structural medication reconciliation during the admission, transfer, or discharge of patients, as well as the implementation of training programs for physicians and hospital pharmacists regarding the importance of correct and complete recording of each patient's medication information, will play an important role in preventing DRPs and their consequences. Pharmacists have a key role in the implementation of medication reconciliation. The pharmacist's intervention in the medication reconciliation process is more effective than other members of the healthcare providers.

Ethics statement

Our study was performed after receiving the code of ethics by the Tehran University of Medical Sciences research ethics committee, Tehran, Iran, (code number: IR.TUMS.TIPS.REC.1400.027)

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