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Original Article

Evaluation of Drug Prescription Patterns and Interactions in a Tertiary Teaching Hospital in Kerman, Iran

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Abstract

The rational use of drugs is a priority in health policy. Limited studies have been conducted about drug consumption in hospitals. Therefore, we evaluated the pattern of prescription and drug-drug interactions in cardiovascular and gastrointestinal wards. This retrospective study was conducted in a tertiary teaching hospital in Kerman. Data included demographic information and indicators such as type, category, and drug administration route. Diagnosis, outcome, and hospitalization days were other data extracted from the registered patients' information. An online interaction checker of Drug.com (IBM Micromedex) was used to detect drug interactions. Analysis was computed using SPSS V22. Our findings showed that 50.7% of the patients were male in the gastroenterology ward, and 49.3% were female. Patients aged 59±0.7 years and days of hospitalization ranged between 2 to 18 days. Proton pump inhibitors (PPIs) as pantoprazole (28.4%), antibiotics (23.3%) as ceftriaxone, metronidazole and anticoagulant (21.7%) as heparin were the most prescribed drug categories in gastroenterology ward. In the cardiovascular ward, 41.6% of the patients were male and 58.4% female, aged 57 ± 1 years, and days of hospitalization ranged between 3 to 12 days. Anticoagulants/antiplatelets (29.1%), PPIs (13.8%), statins (11.9%), and beta blockers (10.7%) were the most prescribed drug categories in cardiovascular wards. No major drug interaction was seen in gastroenterology inpatients, but major interactions, mainly due to clopidogrel administration, were observed in 11% of cardiovascular ward inpatients. The pattern of drug prescription was based on diagnosis. No correlation was found between drug interaction with diagnosis, outcome, and sex in any of the departments, but a significant correlation was found between drug interaction with patients' age. In conclusion, appropriate prescribing of drugs based on diagnosis was seen in both wards. The pattern of drug use was rational and comparable to similar documents. Also, lower potential drug interactions could be considered as a notable result.

Keywords: Drug pattern, Drug interaction, Drug utilization, Gastroenterology, Cardiovascular, Hospital, Iran.

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1. Introduction

Appropriate drug use is a very crucial aspect of patient care and disease treatment. Since efficient health care service rests on rational prescription of medicine and correct dispensing, proper drug use is mandatory to maintain general society health. It is one of the priorities of pharmaceutical policies [1]. Rational drug use consists of appropriate prescribing for the appropriate patient based on appropriate diagnosis, prevention, and treatment of diseases [2]. At the same time, irrational use of drugs could be associated with adverse drug reactions for patients and is considered the healthcare system's fault, especially in developing countries [3]. In developing countries, drug-drug interactions, adverse side effects, and antibiotic resistance are increasing as a consequence of irrational drug use [4].

A WHO publication, "The World Medicine Situation," declared that global medicines costs reached \$1.4 trillion in 2020, and more than half of the people consume more than one dose per person per day of medicines [5]. This proportion is increased more rapidly in developing countries like Iran, where most prescriptions are still inappropriate, irrational, and far from WHO standards [6, 7]. Meanwhile, the central part of the drug budget in developing countries is spent in hospitals where inadequate drug use and medical errors are still making news [8, 9].

Patients hospitalized in cardiovascular departments are more exposed to drug interactions and complications because they are often old and take many medications [10]. On the other hand, the prevalence of gastrointestinal disease has increased all over the world due to lifestyle, dietary habits, and socioeconomic changes, and especially the exaggerated use of drugs such as NSAIDs and corticosteroids [11]. Interestingly, an investigation on trends of drug prescription in Iran showed that these medicines, which are associated with gastrointestinal adverse effects, are among the most widely used and prescribed drugs [12].

This study was performed to evaluate drug prescription patterns in two hospital wards in a tertiary teaching hospital in Kerman, Iran, using indicators such as drug classification, type, and the route of administration of drugs. Limited studies have been conducted in the field of drug consumption patterns in hospitals. The drug prescription pattern, drug interactions, and related factors provide insight to inform healthcare personnel and may assist the policymakers in developing and updating health policy and, if necessary, provide changes in prescribing patterns [13].

2. Materials and Methods

This observational retrospective study was conducted among indoor patients of gastroenterology and cardiovascular wards of Afzalipour Educational Hospital of Kerman University of Medical Sciences from March to August 2023. Before commitment to study, ethical approval was granted by the Ethical Committee of Kerman University of Medical Sciences (IR.KMU.AH.REC.1400.243 and IR.KMU.AH.REC.1400.314).

Data were collected from all patients admitted to gastroenterology (n=202) and cardiovascular (n=300) wards. Demographic information such as gender, age, type of prescribed drugs, route of administration (oral and injection), drug category, drug interactions, diagnosis, hospitalization days, and outcome were extracted from the registered patients' information. The names of the patients and therapists were anonymous to researchers [14]. We used the drug interaction checker tool from the Drugs.com website that classified drug minor, moderate, interactions into and significant. It is an online pharmaceutical encyclopedia with reference content from the U.S. Food and Drug Administration (FDA) and Harvard Health Publications. Drug.com's database of interaction checkers of Drug.com was based on IBM Micromedex, one of the most accurate software in this regard [15]. The collected data generated a data form suitable for SPSS software.

Data were expressed either as numbers or frequency. Descriptive statistics and data comparison were computed using chi-square, ttest, and one-way analysis of variance (ANOVA) when required. The statistical evaluation was conducted using SPSS software version 22.0 (IBM Corporation, Armonk, NY, USA). A P value less than .05 was considered significant.

3. Results and Discussion

A total of 665 drugs were prescribed for 300 patients in the gastroenterology ward, and 1970 drugs were prescribed for 202 patients in the cardiovascular ward during 2 to 18 days and 3 to 12 days of hospitalization, respectively. In the gastroenterology ward, 152 (50.7%) were male, and the mean age was 59 \pm 0.7 years; in cardiovascular wards, 118 (58.4%) were females, and the mean age was 57 \pm 1 years. The mean of hospitalization days for patients in gastroenterology and cardiovascular departments were 5.1 \pm 0.3 days (2 to 18) and 4.1 \pm 0.7 days (3 to 12), respectively (**Table 1**). The gender distribution, mean age, hospitalization days, and outcome were similar in the two wards.

Table 2 showed that proton pump inhibitors (PPIs), antibiotics, and anticoagulants were the most prescribed category in the gastroenterology ward (28.4%, 23.3%, and 21.7%, respectively). They included more than 70% of the total prescriptions. Our results showed that 28.4% of hospitalized patients in the gastroenterology ward received PPIs, which is significantly lower than a similar study conducted by Gamelas et al. (2019), which indicated that 46.5% of hospitalized patients in an internal medicine ward were on PPIs at admission and 55% at discharge and the majority of them without any appropriate indication [16]. Ceftriaxone and metronidazole were the most frequently prescribed drugs among antibiotics (46% and 28%, respectively), followed by other antibiotics such as vancomycin, meropenem, clindamycin, ciprofloxacin and imipenem (Table 3). In agreement with our study, Kaur et al. (2018) reported that ceftriaxone was the most commonly prescribed antibiotic in various departments of a tertiary care hospital in India [17].

At the same time, Amoxicillin-clavulanic acid was the most commonly prescribed antimicrobial in medical patients in two tertiary hospitals in Malaysia [18]. Reihani et al. (2018) reported that cephalosporins (85.2%) were the most commonly prescribed antibiotics in an Academic Emergency Department in Iran [19]. Also, 21.7% of the inpatients received anticoagulants (**Table 3**), which is significantly lower than a similar study conducted by Gamelas et al. (2019) study that reported inappropriate prescription of anticoagulants (36.3%) in hospitalized patients in an internal medicine ward in Portugal [16].

	Gastroenterology N %	Cardiovascular N %
Male	152 (50.7%)	84 (41.6%)
Female	148 (49.3%)	118 (58.4%)
Age (years)	59 ± 0.7	57 ± 1
	Abdominal pain 65%	Diagnostic procedures 52%
Diagnosis	Liver disease 19%	Angina pectoris 31.7%
Diagnosis	Gastric Bleeding 13%	Hypertension 8.3%
	Others 3%	Others 8%
Discharged	93.7%	88.5%
Self-discharged	5.3%	10%
Death	%1	1.5%
Hospitalization	5.1±0.3 days (2 to 18)	4.1±0.7 days (3 to 12)

Table 1. The description of patients enrolled in the study.

Table 2. The frequency of drug categories prescribed in Gastroenterology and Cardiovascular wards.

Gastroenterology			Cardiovascular		
Drugs category	No	%	Drugs category	No	%
PPIs	189	28.4	Anticoag/antiplat	573	29.1
Antibiotics	155	23.3	PPIs	271	13.8
Anticoag/antiplat	144	21.7	Statins	235	11.9
Corticosteroids	38	5.7	Beta Blockers	210	10.7
Antiemetics	35	5.3	Vasodilators	175	8.9
Laxatives	33	5.0	Corticosteroids	170	8.6
Diuretics	27	4.1	ARBs	98	5.0
Statins	21	3.2	Diuretics	95	4.8
Bile ac. Agents	14	2.1	ACE-I	59	3.0
Antacids	9 1.4		Laxatives	42	2.1
		1.4	CCBs	39	2.0
			Digitals	3	0.2

PPIs: Proton-pump inhibitors, ACE-I: Angiotensin Converting Enzyme Inhibitor, Anticoag/antiplat: Anticoagulants /Antiplatelet, ARBs: Angiotensin Receptor Blockers, Bile ac. Agents: Bile acid agents, CCBs: Calcium Channel Blockers.

In our study, Heparin (82%) and ASA (18%) were the most common anticoagulants/antiplatelet prescribed drugs. The pattern of drug class categories prescription was different between genders (X2=41.4, df=9, p=0.000). Gender difference was seen throughout prescription patterns, especially in hospitalized patients [20]. PPI drugs were used more in men, while antiemetics were used more in women. The pattern of drug class categories prescription was also different according to diagnosis (X2=68.9, df=18, p=0.000), which

confirm rational use of drugs [21]. Truly in this study, bile agents, antacids and diuretics were not prescribed for gastrointestinal bleeding.

In the cardiovascular ward, anticoagulants/antiplatelets, PPIs, statins, and beta blockers were the most prescribed category of drugs (29.1%, 13.8%, 11.9% and 10.7% respectively). They included more than 60% of prescriptions (**Table 2**). However, in this ward, 44% of anticoagulants/antiplatelets consisted of ASA, followed by 36% clopidogrel, and (unlike the gastroenterology ward) only 19% of heparin. These results are comparable to a previous study by Muhit et al. (2012) which reported that antiatherogenic (97.67%), lipidlowering agents (95.35%), antianginal (79.07%), and beta-blockers (51.16%) were the most frequently prescribed drugs at a tertiary level hospital in Bangladesh[22]. Also, in Germany, ACE inhibitors (43.8%) or betablockers (32.4%) were the leading drug classes among hypertensive patients [23]. In contrast, Biradar et al. (2018) reported that the combination of diuretics and calcium channel blockers was India's most commonly prescribed dual therapy for cardiovascular disease [24].

The distribution of drug categories showed remarkable differences according to the diagnosis (X2=181, df=55, p=0.000) that show the right prescription for appropriate diagnosis [2]. No significant association was found between the distribution of drug categories and the sex, age, and outcome of hospitalized patients.

In the gastroenterology department, 19 different drugs were prescribed to indoor patients. The most frequent were pantoprazole (28.4%), followed by heparin (17.7%) and ceftriaxone (10.7%)(Table The 3). pantoprazole prescription rate was significantly higher in males, while the ondansetron prescription rate in women was significantly higher than in males (X2=54.7, df=18, p=0.000). Different drugs were prescribed for different diagnoses [2]. Therefore, a significant difference was seen between drugs and diagnosis (X2=101.8, df=36, p=0.000). Most of the drugs were prescribed for those with abdominal pain (466 of 665).

In the cardiovascular department, 20 different drugs were prescribed 1970 times. The most frequent were pantoprazole (13.8%), aspirin 80 (12.8%), atorvastatin (11.9%), and clopidogrel (10.4%) (**Table 3**).

Gastroenterology		Cardiovascular			
Drugs	N	%	Drugs	Ν	%
Pantoprazole	189	28.4	Pantoprazole	271	13.8
Heparin	189	17.7	Aspirin 80	253	12.8
Ceftriaxone	118	10.7	Atorvastatin	235	11.9
Metronidazole	71	6.5	Clopidogrel	205	10.4
Ondansetron	43	5.3	Nitrocontin	175	8.9
Lactulose	35	5.0	Hydrocortisone	170	8.6
Furosemide	33	4.1	Heparin	109	5.5
Aspirin 80	27	3.9	Bisoprolol	103	5.2
Dexamethasone	26	3.5	Losartan	74	3.8
Atorvastatin	23	3.2	Metoprolol	57	2.9
UDA	21	2.1	Captopril	52	2.6
Vancomycin	14	2.1	Spironolactone	50	2.5
Hydrocortisone	14	1.5	Carvedilol	50	2.5
MOM	10	1.4	Furosemide	45	2.3
Meropenem	9	1.4	MOM	42	2.1
Clindamycin	9	1.1	Amiloride	39	2.0
Prednisolone	7	0.9	Valsartan	24	1.2
Ciprofloxacin	6	0.8	Enalapril	7	0.4
Imipenem	5	0.9	Warfarin	6	0.3
		0.8	Digoxin	2	0.2

Table 3. The frequency of all prescribed drugs in Gastroenterology and Cardiovascular wards.

MOM= Milk of Magnesia, UDA= UrsoDeoxycholic acid

Arland et al. (2019) reported that clopidogrel was the most commonly prescribed anticoagulant, followed by low molecular weight heparin in Coronary Artery Patients (CAD) patients in a Coronary Care Unit (CCU) and Medicine ward [25]. However, in our study, Aspirin was the most commonly prescribed drug in the cardiovascular ward, followed by clopidogrel and heparin. Similarly, Vakade et al. (2016) reported that aspirin clopidogrel combination (80.49%), enoxaparin (75.61%), atorvastatin (73.17%), and glyceryl trinitrate (73.17%) were the most commonly prescribed drugs in patients of cardiovascular emergencies at a tertiary care hospital in India [26]. In the cardiology clinic of the University Hospital in Bulgaria, anticoagulants, followed by diuretics and ACE inhibitors, were the most commonly prescribed drug categories [27].

Pantoprazole, heparin, atorvastatin, furosemide, and aspirin 80 mg were used in both departments. Pantoprazole, the most frequent drug, was prescribed 189 times in gastroenterology and 271 times in cardiovascular wards (Table 3). Given the multiuse, high efficacy, and low side effects, PPI prescription is increasing all over the world, almost 25% of the people particularly females use PPIs [28]. Aspirin 80mg was the second most commonly prescribed drug in the cardiovascular ward, but in gastroenterology, it was the 8th most commonly prescribed drug. Also, heparin was the second most frequently prescribed drug in the cardiovascular ward, but in gastroenterology, it was the 7th most frequently prescribed drug. (**Table 3**). The cardiovascular department had a significant correlation between diagnosis and drug prescribed (X2=180.6, df=55, p=0.000). Most drugs (979 of 1970) were prescribed for those referred to the hospital for diagnosis procedures.

The pattern for the route of administration was not similar in the two departments. Drugs were injected 488 times in the gastroenterology ward (73% of all drugs), while in the cardiovascular department, injected drugs consisted of just 14% of all drugs (prescribed 278 times).

In Figure 1, the frequency of drug interaction showed almost no major drug interaction in prescriptions of the gastroenterology ward; however, in the cardiovascular ward, most prescriptions were associated with either major or moderate drug interactions. In the cardiovascular ward, most drug interactions were moderate (86%), followed by major interactions (11%) and minor interactions (0.3%) due to clopidogrel, heparin, and other anticoagulants.



Figure 1. Drug interaction frequency in prescription in gastroenterology and cardiovascular ward. No interaction was most frequent in the gastroenterology ward, while minor drug interaction was most frequent in the cardiovascular ward.

The mean age of those with major interactions (61.2 ± 2.2 years) and those with moderate interactions (59.4 \pm 0.7 years) were significantly less (P<0.0001) than those with no interactions (39.5 ±5.7 years). In the gastroenterology department, only 28% of drug interactions were moderate, with no interaction for 70% of prescriptions. Almost no major interaction (0.5%) (Fig. 1). The mean age of patients with moderate interaction was 62.5±1.3 years, which was significantly (P<0.005) more than those without any interaction (54.4 ± 1.3) years). However, no correlation was found between drug interaction with diagnosis, outcome, and sex in any of the departments.

Our results showed that the potential drugdrug interactions (PDDIs) in the cardiology department in Kerman (Fig. 1) were significantly lower than in a similar study in India (30.67%). However, most PDDIs were clopidogrel interactions, as in our study [29]. Also, in another study conducted in Iran, the most frequent drugs responsible for PDDIs were aspirin and clopidogrel [30]. The frequency of PDDIs in Shiraz, Iran (43.43 %), Ethiopia (77.4% in 521 out of 673 patients), Nepal (21.3%), and Brasilia (49.7%) were significantly higher than in our study [29-33]. Polypharmacy (more than six drugs per prescription), old age (60 years or more), and hospital stays of 7 days or longer are the major risks for the occurrence of PDDIs [34-36]. Following this study, old age was associated with the severity of drug interactions. However, we did not observe a significant correlation between drug interaction with sex, hospitalization duration, diagnosis, or outcome. Urbina et al. (2015) reported that female sex could be associated with a higher risk of potential drug interactions [37]. Figure 1 also

showed no major drug interactions in the gastroenterology ward, which could indicate an appropriate drug prescription. However, other investigators reported a higher rate of both potential and moderate drug interactions in hospitalized patients in internal wards. Ismail et al. (2013) reported that 21.3 % of prescribed drugs in internal wards in Pakistan were associated with at least one major-PDDI and 44.3 % with at least one moderate-PDDI [38]. In comparison to our study, other investigators reported higher potential drug interactions in internal wards (Ethiopia: 12.8%, India: 31.1%, Saudi Arabia: 8.5%, and 13.7% in Switzerland) [34, 39, 40]. Sepehri et al. (2012) reported potentially severe drug-drug interaction in 10.8% of hospitalized patients in an Iranian General Hospital, with digoxin-furosemide as the most common interacting pair (5.91%) [41].

4. Conclusion

The results showed that PPIs (such as pantoprazole), antibiotics (such as ceftriaxone and metronidazole), and anticoagulants (such as heparin) were, respectively, the most prescribed drug categories in the gastroenterology ward. In the cardiovascular ward, anticoagulants/antiplatelets (as clopidogrel and ASA), PPIs (as pantoprazole), and statins (as atorvastatin) were the most commonly prescribed drugs, respectively. These outcomes indicate that the patterns of drug prescription in this study were comparable to other previously reported documents and indicate appropriate drug prescription based on diagnosis. Also, the limited potential of drug interactions showed a remarkable rational drug prescription pattern in a tertiary teaching hospital in Iran.

Conflict of interest

The authors declare to have no conflict of interest.

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