

Original Article

Frequency and types of the medication errors in an academic emergency department in Iran: The emergent need for clinical pharmacy services in emergency departments

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ABSTRACT

Objective: Emergency departments (EDs) are characterized by simultaneous care of multiple patients with various medical conditions. Due to a large number of patients with complex diseases, speed and complexity of medication use, working in under-staffing and crowded environment, medication errors are commonly perpetrated by emergency care providers. This study was designed to evaluate the incidence of medication errors among patients attending to an ED in a teaching hospital in Iran.

Methods: In this cross-sectional study, a total of 500 patients attending to ED were randomly assessed for incidence and types of medication errors. Some factors related to medication errors such as working shift, weekdays and schedule of the educational program of trainee were also evaluated.

Findings: Nearly, 22% of patients experienced at least one medication error. The rate of medication errors were 0.41 errors per patient and 0.16 errors per ordered medication. The frequency of medication errors was higher in men, middle age patients, first weekdays, night-time work schedules and the first semester of educational year of new junior emergency medicine residents. More than 60% of errors were prescription errors by physicians and the remaining were transcription or administration errors by nurses. More than 35% of the prescribing errors happened during the selection of drug dose and frequency. The most common medication errors by nurses during the administration were omission error (16.2%) followed by unauthorized drug (6.4%). Most of the medication errors happened for anticoagulants and thrombolytics (41.2%) followed by antimicrobial agents (37.7%) and insulin (7.4%).

Conclusion: In this study, at least one-fifth of the patients attending to ED experienced medication errors resulting from multiple factors. More common prescription errors happened during ordering drug dose and frequency. More common administration errors included drug omission or unauthorized drug.

Keywords: Emergency department; incidence; medication errors

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INTRODUCTION

Medication errors have been defined as "failure in the treatment process that lead to or has the potential to

lead to harm to the patient."^[1,2] Medication errors may occur at each five stages of drug ordering and delivery including prescription, transcription, dispensing, administration or monitoring.^[1-3] Medication errors occur in 2-14% of hospitalized patients and lead to 44,000-98,000 annual deaths in the United States.^[4] Emergency departments (EDs) are characterized by simultaneous care of multiple patients with various complex medical conditions most of them are acutely ill. Large volume of patients with complex diseases seeking medical treatments, medical information gaps among them, speed and complexity of medication use, working in under-staffing, crowded environment

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and in hard conditions such as disrupted sleep cycles, multiple interruption, acute time constraint and prevalent verbal ordering are contributing causes for medication errors by emergency care providers.^[3,5-7] Medication errors rates have been estimated between 4% and 14% in EDs and even higher among pediatric EDs.^[8,9] Regarding the importance of medication errors consequences in EDs and scarce data from Iran, this study was performed to determine the frequency and types of medication errors and related factors among patients attending to an ED in a teaching referral hospital in Iran.

METHODS

This cross-sectional study was performed at a 46-bed ED of an academic hospital in Tehran, Iran, since early October 2011 to early October 2012. Patients with ED stay longer than 6 h who were administered at least one drug were eligible to be enrolled. The medication errors were gathered in pre-designed forms included patients demographic data (age, sex, weight, height), chief complaint, admission diagnosis, past medical and drug history, patients' medications at ED (name, dosage form, dose, frequency and route of administration), patients clinical findings and laboratory data including kidney and liver function tests and level of electrolytes. Medication errors were categorized according to the coding system of Pharmaceutical Care Network Europe Foundation^[10] to three stages of prescription, transcription and administration. In prescribing stage, some important factors were the selected drugs, lack of contraindications, drug dose and dosage form, missed required drugs, frequency of drug administration and control of drug interactions. For transcription stage, the congruence of nursery charts and physician's orders were evaluated. The administration errors were assessed by disguised observations of preparing drugs, dilution methods of parenteral medications, storage conditions and administration routes by nurses. The rate of medication errors was calculated by dividing the number of medication errors by the number of patients and the number of ordered drugs. This research has been approved by Ethics Committee of Tehran University of Medical Sciences.

Data was analyzed using Statistical Package for the Social Sciences (version 13.0) software (SPSS; Chicago, Illinois, USA). Categorical and continuous variables were presented as a percentage and mean \pm standard deviation, respectively. Incidence rates were calculated using descriptive statistics. ANOVA test was used to compare rates of medication errors in different work shifts, different days of the week, or different seasons of the year.

RESULTS

Considering the prevalence of medication errors of 20% in the emergency wards and error precision of 3.5% and alpha error of 5%, the sample size for this cross-sectional study was calculated to be 500 using the following formula:

$$N = \frac{\left(Z_{1-\alpha/2}\right)^2 \times p(1-p)}{d^2}$$

A total of 500 patients were randomly selected (by random number generator) from eligible subjects and were evaluated. The mean age of the patients was 52.9 ± 18.0 years old (range: 16-79 years); of them, 270 (54%) were male. Thirty patients (27.3%) were aged from 16 to 44 years, 42 subjects (38.2%) from 45 to 64 years and 38 patients (34.5%) were older than 65 years. Of total 1291 ordered medications for these 500 patients, 204 medication errors occurred in 110 patients. These results show that 22% of patients encountered at least one medication error. The rate of medication errors were 0.41 errors per patient and 0.16 errors per ordered medication. Saturday (beginning of working days in Iran) ($P=0.754$), the long night-time work shift ($P=0.001$), and fall season ($P=0.172$), which is the first semester of educational year of new junior emergency medicine residents were the most common times of medication error occurrence [Table 1]. These differences reached statistical significance just for work

Table 1: Medication errors frequency at different weekly days, work shifts, seasons, and academic educational semesters, during the study period

Parameter	Frequency	Percent
Weekly day		
Saturday (beginning of working day in Iran)	20	18.2
Sunday	18	16.4
Monday	16	14.5
Tuesday	13	11.8
Wednesday	13	11.8
Thursday	15	13.6
Friday	15	13.6
Work shift		
7 a.m to 1 p.m	21	19.1
1 p.m to 7 p.m	31	28.2
7 p.m to 7 a.m	58	52.7
Season		
Spring	23	20.9
Summer	23	20.9
Fall	34	30.9
Winter	30	27.3
Academic educational semester of emergency medicine residents		
First semester	64	58.2
Second semester	46	41.8

shifts. Among 204 recorded medication errors, 60.8% were prescription error, 15.2% transcription type and 24% administration type [Table 2]. Therefore, 60.8% of medication errors were happened by physicians and the remaining by nurses. The most prescribing errors happened during selecting drug dose and frequency of administration (22.6% of errors were high drug dose or frequency and 13.2% were low drug dose or frequency). The most common medication errors by nurses during administration were omission error (ordered drug not given e.g. not administering ordered enoxaparin or some antibiotics) (16.2% of errors) followed by unauthorized drug (given drug not ordered e.g., administering antibiotic without physicians' prescription) (6.4% of errors).

Most of the medication errors happened for cardiovascular drugs especially anticoagulants and thrombolytics (84 [41.2%] errors) followed by antimicrobial agents (77 [37.7%] errors) and insulin (15 [7.4%] errors).

DISCUSSION

Medication errors are common medical faults leading to adverse effects in patients.^[6,7] In this study, 22% of ED patients experienced at least one medication error. 61% of errors were happened by physicians and the remaining by nurses. Most of the errors happened during prescribing as selecting drug dose and frequency. Most administration errors happened as omission drugs followed by unauthorized medications. More errors were occurred in men, middle age patients, first days of the week, nighttime shift works and fall season at the initiation of new trainee and junior emergency medicine residents' education programs.

Data from MedMARx[®], the internet accessible medication error reporting program of United States, showed the medication error rate of 78/100,000 visits in EDs. Physicians and nurses were responsible for 24% and 54% of errors, respectively. Errors mostly occurred at administration node (36%) with the most common type of improper dose (18% of errors) followed by omissions and unauthorized drugs each with the rate of 11%. In this report, most medication errors occurred during 3:00 p.m. to 11:00 p.m. shifts (42% of errors) followed by 7:00 a.m. to 3:00 p.m. (33%) and 11:00 p.m. to 7:00 a.m. (25%) and on Mondays (16.5%) followed by Tuesdays (15%).^[11] Our results show some similarity with MedMARx data as we also saw more errors in the first days of the week and most administration error types of omission or unauthorized drugs, however, most errors happened by physicians not nurses in our study. Fordyce *et al.*, during a 1 week observational study on 1935 patients who admitted to an academic ED reported error rate of 0.18 per patient, of them 16% were related to the pharmacotherapy that means 0.03 medication error per patient.^[5] Rothschild *et al.*, during an observational study at four academic EDs, reviewed 17,320 ordered medications for 6471 patients. They found 504 medication errors that were equal to 0.078 medication errors per patient (ranges from 0.062 to 0.096 between the four hospitals) and 0.029 medication errors per ordered drug (ranges from 0.022 to 0.043 between four hospitals).^[12] These reported error rates^[5,12] are much less than observed medication error rate of 0.41 errors per patient in our study. In Rothschild *et al.*, study, medication errors occurred most commonly for antimicrobial agents (32.1%), central nervous system drugs (16.2%) and anticoagulants and thrombolytic agents (14.1%),

Table 2: Types of medication errors observed in the emergency department of the study hospital (N=204)

Medication error type	Type of error definition	Sub-category	No.	%
Prescription	Interactions	Drug interactions	0	0
		Drug choice problem	Inappropriate route or dose	6
	Dosing problem	Inappropriate repeat of same family drug	0	0
		Contraindications	0	0
		Lack of obvious indications	19	9.3
		No drug prescription despite existence of indication	26	12.8
		Low drug dose or frequency	27	13.2
		High drug dose or frequency	46	22.6
		Short treatment time	0	0
		Long treatment time (not able to follow due to short stay of patients at ED)	0	0
Transcription			31	15.2
Administration	Drug use problem	Ordered drug not given (omission error)	33	16.2
		Given drug not ordered (unauthorized drug)	13	6.4
	Others	Incorrect drug dilution	3	1.4
		Incorrect drug storage	0	0

ED=Emergency department

followed by cardiovascular drugs (12.7%) and hormonal agents including insulin (6.7%).^[12] In our study, more errors were identified for anticoagulant/thrombolytic agents (41.2%) with approximately similar error rates as reported by Rothschild *et al.*,^[12] for antimicrobial and insulin. Higher rate of errors on anticoagulant/thrombolytic agents in our ED may be due to higher admitted patients with cardiovascular events. As seen in our study, medication errors in Rothschild *et al.*, study were mostly happened during prescribing by physicians (92.3%) and fewer during drug administration by nurses (4.4%) and remaining (3.4%) during transcription, dispensing, or monitoring by nurses, pharmacists or physicians. The most common types of medication errors were dosing error (16.8% under-dose and 12.5% overdose), drug omission (10.5%) and wrong frequency (8.2%).^[12] In another study in four rural pediatric EDs on 177 patients, a total of 84 medication errors identified among 69 children showing that 39% of patients experience at least one medication error in these wards.^[8] The incidence and types of medication errors in this study are consistent with our results. They reported the incidence of 0.47 medication errors per patient. More than 28% of the errors happened by physicians. Administration errors were the most common type of medication errors (70.2% of errors) with unauthorized drug (47.6%) as the most common type of error followed by omission drug (21.4%).^[8] Kozer *et al.*, reported 10.1% incidence rate of prescribing medication errors in the pediatric patients at ED. In their study, specific time periods including weekends and 4 a.m. to 8 a.m. were associated with increased risk of medication errors. They also reported more medication errors by trainees at the beginning of the training year.^[13] Higher incidence of medication errors at the beginning of educational year of junior emergency medicine residents were identified in our study as well. Thus, inexperience and lack of supervision play significant roles in the occurrence of medication errors.

Awareness to medication errors in hospitalized patients started during the last decade in Iran following implementation of clinical pharmacy services in a few academic hospitals. There are few reports on medication errors surveillance in hospitalized patients in Iran. The study by Khalili *et al.*, in the infectious disease ward revealed the medication error rate of 0.13 errors per patient.^[14] This amount is less than that observed in the present study that may be due to special complex nature of EDs as previously mentioned.^[3,5-7] In Khalili *et al.*, study, physicians and nurses were responsible each for about 50% of errors. They similarly reported the drug dosing as the most common type of

medication error. As suspected from specialized infectious disease wards, most medication errors happened on non-antibiotic drugs with the most prevalent errors on anticoagulant agents followed by gastrointestinal drugs and hypoglycemic agents including insulin. Errors occurred more commonly in men and middle-age patients.^[14] In another study by Khalili *et al.*, at an academic infectious disease ward, medication error rates were reported as 0.05 per ordered drug and 0.3 per patient. In this study, more than 70% of errors occurred during prescription with the most prevalent types of incorrect dose, drug omission and incorrect drug. In their study, transcription errors consisted 2.6% of medication errors.^[15] Vessal from Iran reported a prescription error rate of 60% in nephrology ward with the highest rate for dose and frequency errors as seen in our study.^[16] Another study by Dashti-Khavidaki *et al.*, in nephrology and infectious disease wards in Iran showed that clinical pharmacists would have prominent roles in decreasing the rate of medication errors and related cost in hospitals.^[17]

Some differences in reported medication error rates between different studies may be related to different types of study design, settings (different medical wards), medication errors definition and classification and methods and sources of medication error detection and reporting. Higher rate of prescription errors in Iranian studies may be due to ever using traditional paper-based prescription system instead of computerized physician order entry eliminating errors related to illegible handwriting, transcription errors by nurses and also give alarm upon the occurrence of major drug interactions or dosage errors. Furthermore, clinical pharmacists' participation in medical teams has been proven to reduce medication errors in hospitalized patients especially at critical care settings.^[18] In Iran, clinical pharmacists are few in numbers and are not present in most hospital wards yet.

The probable causes of higher rate of errors among men that was observed in our study have been suggested by authors as higher severity of disease resulted to attendance to the emergency ward and attending in night hours with lower precision among physicians due to being involved in diurnal hours by job activities. Another finding in this study was a higher rate of medication errors among middle age patients that may be due to these causes: First the younger patients have better health status and would require less need to hospital attendance and the elderly subjects have higher mortality risk in pre-hospital stage; and the second cause is that elderly subjects usually have chronic stable diseases that would require attending to self-physician

and less attendance to EDs. The higher rate of medication errors in nighttime shifts is expected and may be related to less precision among physicians, less patients responsiveness and cooperation for giving a good clinical history that would result in inappropriate treatment.

In conclusion, at least one-fifth of patients attending to our ED would experience medication errors. Medication error rates in our ED was higher than those reported from some developed countries. More common prescription errors happened during ordering drug dose and frequency. More common administration errors include drug omission or unauthorized drug. Therefore, the more common types or errors in our ED were compatible with those reported from other countries.

There are some limitations for our study, the main one is that during this cross sectional study we did not assess all the patients who admitted in the ED and assessed randomly just 500 patients. We also did not follow the patients beyond the observation session and not compare the clinical outcome between patients who received and not received medication errors.

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AUTHORS' CONTRIBUTION

Dr. Alireza zeraatchi actively participated in data gathering and analysis. Dr. Mohammad-Taghi Talebian contributed in data gathering. Dr. Amir Nejati contributed in study idea and design. Dr. Simin Dashti-Khavidaki participated in study design, data interpretation, and manuscript writing.

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