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The relationship between incidence and report of medication errors and working conditions

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Background: Medication errors are considered to be a serious threat to patients' safety. Efforts to detect and prevent these errors have increased considerably in recent years.

Aim: To determine the incidence and reporting rate of medication errors as reported by Iranian nurses and their relationship with work conditions in hospitals under the authority of Iran University of Medical Sciences.

Methods: This descriptive-analytical study was carried out in six hospitals. Through a stratified multiple stage sampling, 300 nurses were selected. A researcher-constructed, three-part, self-report questionnaire was used to collect data regarding the nurses' medication errors, medication error reports and their perceived working conditions during the previous 3 months. The data were processed using descriptive statistics and Kruskal–Wallis one-way analysis of variance.

Findings: The mean of medication errors that nurses recalled was 19.5, and the mean of error reporting was 1.3 cases during the previous 3 months. The relationship between error incidence and work conditions as perceived by nurses was statistically significant ($df = 3$, $P \leq 0.0001$); however, there was no significant relationship between reporting the occurred error and nurses' perceived work conditions ($df = 3$, $P \leq 0.255$).

Conclusion and implications: The establishment of an efficient reporting system, documentation of errors and removal of obstacles to reporting may result in reduced frequency of medication errors. Considering the relationship between medication error incidence and working conditions, it seems that creating a work condition in which nurses feel more comfortable and decreasing work tensions may pave the way to preventing nursing errors.

Keywords: Hospital Working Conditions, Iran, Medication Error, Nursing, Reporting

Introduction

Medical errors are a challenge threatening health care systems in every country. Of the known medical errors, medication errors are one of the most common types (Sanghera et al. 2007). Medication errors present a global problem and can lead to serious consequences and even patient death. These errors are listed as one of the five medical error categories classified by the American Institute of Medicine (Mrayyan et al. 2007).

The adverse effects of medications are becoming increasingly onerous. Although consensus exists that strategies are needed to alleviate these problems, currently they are not clearly the responsibility of any one professional group (Jordan 2002). It is crucial to prevent medication errors because, as well as being costly, they have also been proven to contribute negatively to patient safety, which is of priority to health care systems all over the world (Brown 2001; Ovretveit & Sachs 2005; Pronovost et al. 2005).

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A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm, while the medication is in the control of the health care professional, patient or consumer (Brady et al. 2009). Such events may be related to professional practice, health care products, procedures and systems, including prescribing; order communication; product labelling, packaging and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use (NCC MERP 2005).

Medication errors have attracted much attention because of their countless complications and the tendency on behalf of the related health care system to reduce relevant expenses and numbers of staff.

Drug administration is a routine but important part of nursing practice, which requires special skills, technique and knowledge in order to attend to patients. Medication errors can cause serious problems in nursing practice and expose patients to preventable threats. When a medication error occurs, nurses' performance is undermined more than that of any other health care professional (e.g. physicians). Therefore, it is often the nurses who are held responsible (Mrayyan et al. 2007). This may be because nurses often carry out medication orders and with this comes greater responsibility, as they are in charge of both the medications and the patients' safety (Verajankorva et al. 2006). Practical advice, which can be followed by nurses or carers independently of prescribers, expands the opportunities to improve care (Jordan et al. 2004); hence, emphasizing the need for nurses to play a more active role in the prevention of medication errors (Aiken et al. 2002; Benjamin 2003). Globally, adverse drug reactions (ADRs) make a substantial contribution to ill health. Introducing a systematic approach to patient surveillance could mitigate these problems. Formalized medication monitoring schedules have been proposed as one strategy to diagnose and act on side effects and the problems emanating from ADRs (Jordan et al. 2004).

The incidence of medication errors varies depending on the study, and it is difficult to acquire precise figures (Alanko & Nyholm 2007). According to a study on medical errors published in the USA, annual deaths from medication errors accounted for 7000 out of the total number of 48 000–98 000 deaths because of drug complications (Kohn et al. 2000).

Much has been written on the burden of disease often at the expense of the 'burden of treatment'.

Errors cause distrust and dissatisfaction of patients with health care systems (Institute of Medicine 1999) and can also lead to stress and moral issues among nursing staff (Osborne et al. 1999). Medication errors negatively affect patients, nurses and organizations and reduce health care efficiency. Therefore, finding the causes and solutions to this problem should be a top priority for any health care system. Studies show that most errors occur when prescribing and administering drugs. Errors in the former are usually attributed to doctors' malpractice, while nursing staff usually are responsible for errors during drug administration (Lassetter & Warnick 2003). Approximately half of all medication errors are reported to be preventable (Thomas et al. 2001).

It is difficult to have a general concept of medication errors in less developed and developing countries (Mrayyan et al. 2007). This is not because of a low incidence but rather a result of inefficient documentation and error-reporting systems and insufficient research in the area.

In Iran, although there are no reliable statistics regarding medication errors, experts speculate that it could be very high; the increasing incidence of lawsuits against physicians and nurses to the medical council confirms this speculation (Najafi 2009). Increased mortality and longer hospital stay and costs are some of the direct consequences of medication errors (Mihailidis et al. 2006).

Aim

The aim of this study was to determine the frequency of medication errors and their reporting by nursing staff employed at Iran University of Medical Sciences hospitals and their relationship with hospital working conditions.

Method

This was a cross-sectional, descriptive-analytical study in which the relationship between the incidence and reporting of medication errors by nurses and work conditions from the participants' point of view was studied. The study was carried out between November 2008 and May 2009.

Setting

This study was conducted in major educational and non-educational hospitals under the authority of Iran University of Medical Sciences in Tehran, the capital of Iran.

Sample

The participants were 300 nurses, approximately 100 from each shift in different wards of selected university hospitals. Nurses were selected using stratified multistage sampling method randomly based on the number of nurses employed in each hospital. There are now 691 nurses working in the hospital wards under consideration.

Sampling process

After the approval of the study by the Research and Ethics Committee of Iran University of Medical Sciences and formal permission of the university and authorities at each selected hospital, respondents were chosen from the list of nurses in the nursing

office by taking odd and even numbers from alternating pages. Proportional allocation was used for samples in each centre according to the number of nurses working there. The required number of samples from each centre was determined and selected from the name list until fulfilling the number we calculated for each different type of ward (internal, surgery, orthopaedics and obstetrics/gynaecology) of the hospital. During frequent visits to the hospitals, nurses who did not meet the inclusion criteria for the study were excluded.

Inclusion criteria for the nurses include having a bachelor of science degree and working in general adults' wards for at least 6 months. For data gathering, the researchers entered the hospitals with a prepared appointment during different shifts. Respondents were given information regarding the importance and aims of the study, anonymous, volunteer and confidential of participation. A written consent was obtained from every individual and a questionnaire with explanations was subsequently given. Nurses responded to questions by self-reporting in a safe and stress-free place and time. Filled questionnaires were then collected in person by the researcher 2 days later. The general response rate was 93% ($N = 286$). Fourteen nurses declined to take part.

Measurement

A three-part questionnaire designed by the researcher was used to collect data. This was based on the study performed on various devices and according to study aims (California HealthCare Foundation (US) 2001a,b; Mrayyan et al. 2007).

The first part of the questionnaire collected demographic information consisting of age, sex, university degree, nursing work experience, type of ward (i.e. internal medicine, general surgery, orthopaedics and OB/GYN), work experience in current ward, formal training in drug administration, type of shift (rotating or fixed), type of employment (official, based on contract, employed on contract, serving), employment in one or more hospitals and working extra hours, employment in fields other than nursing and any particular medications.

The second part consisted of 19 statements of medication errors and relative reports by nurses within the preceding 3 months. In this part, nurses wrote down the number of incidences and reports for each statement in columns titled 'number of incidences' and 'number of reports', respectively. Open-ended numerical questions were used in the survey.

The third part of the questionnaire consisted of 22 yes/no questions concerning the nurses' work environment (work conditions) and included issues regarded by nurses to be present in their work environment. This section was scored from 0 to 22 (0–5, very satisfactory; 6–10, satisfactory; 11–15, unsatisfactory; 16–22, very unsatisfactory).

Reliability and validity

After being edited by fellow researchers and the consulting statistician, the questionnaire was reviewed by 19 board members of Iran School of Nursing and Midwifery in terms of content clarity. The comments helped the researchers to amend the tool and the revised version was confirmed. To confirm the questionnaire's reliability, internal consistency was calculated using Cronbach's alpha ($\alpha = 0.84$).

Data analysis

The statistical analysis was carried out using descriptive statistics, one-way analysis of variance and Kruskal–Wallis tests for response to the study aim. Data were entered into the statistical package for the social sciences version 16 for windows (SPSS Inc., Chicago, IL, USA). We began the study after the proposal confirmation by the university ethics committee.

Interpretation of results

The participants were 286 nurses. The majority were female (90.9%) and below 30 years old (72.4%) and more than half (60.8%) had less than 5 years of nursing experience. More than one-third (39.9%) were employed on contract; the majority worked rotating shifts (73.1%) and were employed in internal medicine wards (61.2%). Just over one-third (36.4%) had drug administration training. All nurses held a bachelor's degree, only 8% were employed in work other than nursing, and 27.6% were employed in one or more than one hospitals and working extra hours. In the present study, the average number of medication errors self-reported by each nurse was 19.5 cases (during the previous 3 months) and that of error reporting was an average of 1.3 cases. This means that the nurses acknowledged that they made on average 19.5 medication errors per 3-month period but reported only 1.3 of error cases. The findings showed that the relationship between nursing medication errors and working conditions was significant ($P \leq 0.0001$). However, the relationship between the average number of error reports and working conditions was not significant ($P \leq 0.255$).

Tables 1 and 2 show the average number of medication errors and reports vs. working conditions for the hospitals under study, and the raw data are provided in the Appendix (Tables S1–S19).

Limitations of the study

Self-reporting is believed by many researchers to contribute to the limitations of studies, but with regard to medication errors, it still remains one of the most common and practical means of detecting and estimating error incidence (Balas et al. 2004; Mrayyan et al. 2007). The nurses still expressed doubts regarding the confidentiality of the results, which made the work more complicated. The researchers' good communication with the

Table 1 Average nursing medication error vs. work conditions

Work conditions / *Medication error*		*Very satisfactory*	*Satisfactory*	*Unsatisfactory*	*Very unsatisfactory*	*Kruskal–Wallis test*
1. Not administering a prescribed drug to the patient	$\bar{x}^*\pm$SD	0.30 ± 1.129	0.18 ± 0.71	0.63 ± 1.43	1.22 ± 2.51	χ^2† = 16.537 df = 3 $P \leq 0.001$
2. Administering drug without doctor's orders	$\bar{x}\pm$SD	0.45 ± 0.999	0.61 ± 1.887	1.17 ± 2.291	3.54 ± 6.61	$\chi^2 = 18.116$ df = 3 $P \leq 0.000$
3. Administering drug before or after appointed time	$\bar{x}\pm$SD	0.60 ± 2.234	1.5 ± 4.142	4.23 ± 6.73	5.39 ± 8.16	$\chi^2 = 19.269$ df = 3 $P \leq 0.000$
4. Not diluting drug which must be diluted	$\bar{x}\pm$SD	0	0.02 ± 0.147	0.45 ± 2.267	1.65 ± 4.86	$\chi^2 = 20.540$ df = 3 $P \leq 0.000$
5. Inappropriate time (before/after meal) for administering drug	$\bar{x}\pm$SD	0.25 ± 0.786	0.07 ± 0.325	2.22 ± 5.657	2.5 ± 5.153	$\chi^2 = 26.870$ df = 3 $P \leq 0.000$
6. Not taking necessary steps (e.g. determining pulse, BP, etc.) regarding particular drugs	$\bar{x}\pm$SD	0.05 ± 0.224	0.24 ± 0.817	1.13 ± 3	3.54 ± 6.64	$\chi^2 = 24.332$ Df = 3 $P \leq 0.000$
7. Mixing two or more drugs in microset without considering interactions	$\bar{x}\pm$SD	0.10 ± 0.447	0.18 ± 1.266	0.43 ± 2.83	1.39 ± 3.683	$\chi^2 = 14.873$ df = 3 $P \leq 0.002$
8. Infusing drug faster than should be infused	$\bar{x}\pm$SD	0.25 ± 0.786	0.7 ± 2.843	1.59 ± 4.66	2.19 ± 4.899	$\chi^2 = 10.013$ df = 3 $P \leq 0.018$
9. Intravenous injection of subcutaneous drug	$\bar{x}\pm$SD	0	0.03 ± 0.179	0.03 ± 0.157	0.13 ± 0.702	$\chi^2 = 10.877$ df = 3 $P \leq 0.018$
10. Subcutaneous injection of intravenous drug	$\bar{x}\pm$SD	0	0.02 ± 0.209	0.01 ± 0.91	0.02 ± 0.136	$\chi^2 = 0.597$ df = 3 $P \leq 0.897$
11. Intramuscular injection of intravenous drug	$\bar{x}\pm$SD	0	0	0.05 ± 0.254	0	$\chi^2 = 10.013$ df = 3 $P \leq 0.071$
12. Intravenous injection of intramuscular drug	$\bar{x}\pm$SD	0	0.1 ± 0.575	0.14 ± 0.612	0.76 ± 2.092	$\chi^2 = 7.814$ df = 3 $P \leq 0.050$
13. Administering biting sublingual drug to be swallowed	$\bar{x}\pm$SD	0	0.02 ± 0.209	0.75 ± 4.044	1.06 ± 3.356	$\chi^2 = 16.416$ Df = 3 $P \leq 0.001$
14. Administering several oral drugs simultaneously	$\bar{x}\pm$SD	2.35 ± 5.264	4.17 ± 6.226	7.06 ± 8.030	7.33 ± 8.661	$\chi^2 = 18.560$ df = 3 $P \leq 0.000$
15. Administering painkiller without doctor's order	$\bar{x}\pm$SD	0.7 ± 1.720	1.2 ± 3.235	1.14 ± 3.371	2.91 ± 5.73	$\chi^2 = 6.879$ df = 3 $P \leq 0.079$
16. Administering the wrong drug	$\bar{x}\pm$SD	0	0.08 ± 0.539	0.33 ± 1.168	0.52 ± 1.27	$\chi^2 = 15.224$ df = 3 $P \leq 0.002$
17. Administering drug more/less than prescribed dose	$\bar{x}\pm$SD	0.15 ± 0.671	0.16 ± 0.668	0.43 ± 1.235	0.87 ± 2.224	$\chi^2 = 7.304$ df = 3 $P \leq 0.063$
18. Administering drug without a defined route	$\bar{x}\pm$SD	0	0.01 ± 0.104	0.21 ± 1.837	0.06 ± 0.302	$\chi^2 = 2.569$ df = 3 $P \leq 0.463$
19. Not considering appropriate position of patient based on type of drug	$\bar{x}\pm$SD	0	0.02 ± 0.209	0.3 ± 1.939	1.09 ± 4.011	$\chi^2 = 15.455$ df = 3 $P \leq 0.001$
Total	$\bar{x}\pm$SD	5.2 ± 10.3	9.32 ± 14.87	22.28 ± 31.72	36.15 ± 41.15	$\chi^2 = 47.696$
	Med	0	3	13	19	df = 3 $P \leq 0.000$
	IntQ‡ ($Q_3 - Q_1$)	7.75	13.75	26.75	50.5	

*Mean.
†Result of the Kruskal–Wallis test.
‡Interquartile range.

participants in addition to knowing the research environment helped ensure trust with the nurses.

Discussion

According to the results, the average number of medication errors in the previous 3 months per nurse was 19.5 cases. In the study in Jordan by Mrayyan et al. in 2005 this figure stood at 2.2 in a 3-month period (Mrayyan et al. 2007). Stratton et al. found results showing lower rates of errors in Colorado, USA. Those who had collected data by means of self-reporting by nursing staff found results showing medication error rates of 14.8 and 5.6 per 1000 patients in paediatrics and adult wards, respectively (Stratton et al. 2004).

The substantial difference between the results of this study and those of Western countries could be a result of problems such as lack of sufficient human workforce in the health care system

Table 2 Average reporting of medication error vs. work conditions

Work conditions		*Very satisfactory*	*Satisfactory*	*Unsatisfactory*	*Very unsatisfactory*	*Kruskal–Wallis test*
Medication error						
1. Not administering a prescribed drug to the patient	$\bar{x}^*\pm$SD	0.05 ± 0.224	0.05 ± 0.374	0.1 ± 0.64	0.13 ± 0.702	χ^2† = 1.63 df = 3 $P \leq 0.653$
2. Administering drug without doctor's orders	$\bar{x}\pm$SD	0	0.21 ± 1	0.13 ± 0.477	0.52 ± 1.96	$\chi^2 = 3.349$ df = 3 $P \leq 0.341$
3. Administering drug before or after appointed time	$\bar{x}\pm$SD	0	0.08 ± 0.474	0.22 ± 1.197	0.37 ± 1.64	$\chi^2 = 1.409$ df = 3 $P \leq 0.703$
5. Inappropriate time (before/after meal) for administering drug	$\bar{x}\pm$SD	0.1 ± 0.447	0	0.06 ± 0.49	0	$\chi^2 = 4.957$ df = 3 $P \leq 0.175$
6. Not taking necessary steps (e.g. determining pulse, BP, etc.) regarding particular drugs	$\bar{x}\pm$SD	0	0.05 ± 0.521	0.03 ± 0.274	0.28 ± 1.51	$\chi^2 = 2.741$ df = 3 $P \leq 0.433$
7. Mixing two or more drugs in microset without considering interactions	$\bar{x}\pm$SD	0	0	0	0.28 ± 1.51	$\chi^2 = 8.623$ df = 3 $P \leq 0.035$
8. Infusing drug faster than should be infused	$\bar{x}\pm$SD	0	0	0.02 ± 0.183	0.46 ± 2.793	$\chi^2 = 4.929$ df = 3 $P \leq 0.177$
13. Administering biting sublingual drug to be swallowed	$\bar{x}\pm$SD	0	0	0.01 ± 0.092	0.07 ± 0.428	$\chi^2 = 4.910$ df = 3 $P \leq 0.179$
14. Administering several oral drugs simultaneously	$\bar{x}\pm$SD	0	0.23 ± 1.541	0.19 ± 1.125	0.65 ± 3.371	$\chi^2 = 1.36$ df = 3 $P \leq 0.715$
15. Administering painkiller without doctor's order	$\bar{x}\pm$SD	0	0.14 ± 0.704	0.08 ± 0.38	0.44 ± 1.93	$\chi^2 = 1.868$ df = 3 $P \leq 0.6$
16. Administering the wrong drug	$\bar{x}\pm$SD	0	0	0.1 ± 0.92	0.02 ± 0.136	$\chi^2 = 2.718$ df = 3 $P \leq 0.437$
17. Administering drug more/less than prescribed dose	$\bar{x}\pm$SD	0	0.02 ± 0.209	0.02 ± 0.183	0.04 ± 0.272	$\chi^2 = 0.6$ df = 3 $P \leq 0.896$
18. Administering drug without a defined route	$\bar{x}\pm$SD	0	0	0.02 ± 0.183	0	$\chi^2 = 1.383$ df = 3 $P \leq 0.709$
19. Not considering appropriate position of patient based on type of drug	$\bar{x}\pm$SD	0	0	0	0.19 ± 1.361	$\chi^2 = 4.296$ df = 3 $P \leq 0.231$
Total	$\bar{x}\pm$SD	0.15 ± 0.67	0.79 ± 3.53	0.98 ± 3.51	3.46 ± 12.66	$\chi^2 = 4.058$
	Med	0	0	0	0	df = 3 $P \leq 0.255$
	IntQ‡ ($Q_3 - Q_1$)	0	0	0	0	

*Mean.
†Result of the Kruskal–Wallis test.
‡Interquartile range.

(Hooshmand Behabadi et al. 1999), insufficient medication supervision and lack of a standard system of documentation and error reporting, which, regardless of factors related to individual nurses, depends to a large extent on the management of health care systems. Another issue that may affect results is the definition of medication error in different studies. Medication error was defined very inclusively in the current study, which may show higher errors rate to similar studies. Yet, one should bear in mind that human errors are inevitable in any profession, and it is impossible to eliminate errors completely (Anoosheh et al. 2007). However, correct planning and standard supervision will lead to a reduction in the number of errors and prevent serious consequences. Policy developments in nursing involving increased responsibility for pharmacotherapy will stimulate the development of protocols for the prescription of medications (Jordan 2002). The quality of the medication administration process is also influenced by existence of continuing education programmes for nursing staff (Anselmi et al. 2006).

In this study, the most common medication error was 'inappropriate time (before/after meal) for administering drug' (Table 1). This error was not considered in other research concerning medication errors. The researchers' work experiences in different hospitals indicate that nursing shortages and nurses' high workload results in nurses working under pressure. The consequences are that they start and finish providing medication without considering the meal time-related medication orders. In

most cases, they do not attend to the before/after meal order of the medications.

Nurses can decrease medication errors with the application of patient's five rights of medication administration: right patient, right medication, right dose, right time and right route (Soozani et al. 2007), and then almost 50% of medication errors are preventable (Thomas et al. 2001).

Results showed that the average number of error reports per nurse in the wards under study during the previous 3-month period was 1.3 cases, which was less than the figures in similar studies. In the studies by Mrayyan et al. (2007) and Mayo & Duncan (2004), the average number of error reports was 42.1% and 4.9 cases, respectively, both of which were higher than the results shown in the present study. Stratton et al. (2004) reported a 67- and 56-per cent error-reporting rate in paediatric wards and adult wards, respectively. Although studies show that error-reporting among nurses is at a lower rate than error incidence (Blegen et al. 2001; Gladstone 1995; Osborne et al. 1999; Wakefield et al. 1996), the surprising difference between figures in the present study are seriously concerning as nurses have been reported to believe that only 25% of medication errors documented are reported, and only 3.5% believe that all medication errors should be reported (Osborne et al. 1999).

In our study, some medication errors (5 out of 19) are not reported at all (Table 2). In addition to a lower level of report in comparison with errors, this can also be related to a lower occurrence of those errors.

Studies have shown that medication error is an important issue in healthcare and more importantly preventing this type of error depends on precise reporting (Mayo & Duncan 2004). Therefore, it is important to evaluate the reasons why nursing staff avoid reporting errors. There are numerous reasons for lack of reporting or a low reporting to incidence ratio. Chiang & Pepper (2006) noted fear, difficult reporting processes and management obstacles as factors that contribute negatively to error-reporting rates. Some studies have shown that the long time needed to document and connect with the medical team is another important factor (Wakefield et al. 1999a,b; Uribe et al. 2002). Other studies have considered fear of reaction by a manager or colleague, being criticized or stigmatized as unqualified, causing negative impressions on patients and being subject to lawsuits as other preventing factors (Mayo & Duncan 2004; Osborne et al. 1999; Uribe et al. 2002; Wakefield et al. 1999a,b). According to previous studies, 63–84% of nurses avoid reporting because of fear of negative reactions by managers or colleagues (Osborne et al. 1999). Another factor is being unaware of or the lack of consensus over the definition of medication error (Uribe et al. 2002; Wakefield et al. 1996), as approximately 16% of nurses are not clearly aware of what is considered a medication error, and 14% do not know when to report an error (Osborne et al. 1999). Studies in Western countries indicate that error-reporting rates are on the rise (Mayo & Duncan 2004; Osborne et al. 1999). In Iran, this matter must be attended to immediately as, by eliminating or removing to the greatest degree the above-mentioned obstacles, nurses may be encouraged to report more medication errors.

Measures such as redesigning work procedures and precise documentation, standardizing procedures and promoting good relationships amongst staff members all decrease the incidence of medication errors and increase reporting rates (Karow 2002). Furthermore, researchers have found that heavy workload, shortage of staff, an unsupportive physical environment, weak bonding between colleagues and insufficient physical resources all prevent reporting of errors by physicians and nurses because of a highly demanding work environment and complex reporting procedures (Jones & Arana 1996; Uribe et al. 2002).

The results of the present study show that there was a significant relationship between nursing medication errors and working conditions. The difference between the average number of errors in different work conditions – 'very satisfactory', 'satisfactory', 'unsatisfactory' and 'very unsatisfactory' – was statistically significant ($P \leq 0.0001$). Therefore, it seems that by improving working conditions from 'very unsatisfactory' and 'unsatisfactory' to 'satisfactory' and 'very satisfactory', the average number of medication errors could be reduced.

The present study confirms the study done by Seki & Yamazaki (2006), who claimed that work conditions affect medication errors, yet this matter has received little attention. Reason (1997, 2000) showed that work conditions such as shortage of time and workforce, poor facilities and inexperience increase the rate of unsafe clinical practice and clinical errors. In this respect, all but four statements in the present study concerning medication errors (subcutaneous or intramuscular injection of intravenous drugs, administering pain killers after surgery without an order by the physician, administering the wrong dose and administering without having a defined route) had a significant relationship with working conditions.

Improvement in health care systems and work conditions can provide safe health care services (Seki & Yamazaki 2006). Studies in Iran have suggested different measures to decrease error rates, but the majority have not considered working conditions.

Considering the undeniable relationship between work conditions and error incidence especially medication error, measures should be taken to detect and understand these problems and eliminate them in order to decrease medication error rates. Reporting procedures and learning from clinical errors are reported to be weak in hospitals (Sanghera et al. 2007). Important aspects of medication management such as 'information

giving' and 'adverse-effect monitoring' are less clearly addressed (Jordan 2002). Likewise, error-reporting rates were low in the present study. Given the lack of error-reporting systems and documentation, it is irrational to have high expectations of nurses to report errors voluntarily and expose themselves to being criticized and stigmatized. Therefore, it is no surprise that nurses evade reporting errors regardless of the type of work condition they are in.

Conclusion

Given the relationship identified in this study between working conditions and the incidence of medication errors, nursing and hospital managements must undertake measures to facilitate the decrease in error rates by detecting and better understanding such conditions. Therefore, by developing an efficient error-reporting system and precise documentation of error and removing reporting obstacles to the greatest extent possible, one should expect a decrease in medication error rates.

Because a significant statistical relationship was identified between nurses' medication errors and their working conditions, it is recommended that managers should identify the adverse situations in which many in nurses' work, provide safe conditions in the workplace and promote a climate for patients' safety. The most important work condition identified related to medication error was the 'lack of error reporting system', so establishing an anonymous error reporting system in all hospital wards may improve the possibility of nurses reporting errors.

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Author contributions

S. J. was involved in the study conception, design and analysis/interpretation of data, critical revisions for important intellectual content and review of content. F. H. was involved in the study conception, design, acquisition of data, analysis/interpretation of data, drafting of the manuscript and review of content. H. P. was involved in the study conception, design, material support and critical revisions for important intellectual content. N. B. provided statistical technical support. H. H. was involved in the study design, provision of statistical technical support and review of the content.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1 Not administering a prescribed drug to the patient

Table S2 Administering drug without doctor's orders

Table S3 Administering drug before or after appointed time

Table S4 Not diluting drug which must be diluted

Table S5 Inappropriate time (before/after meal) for administering drug

Table S6 Not taking necessary steps (e.g. determining pulse, BP, etc.) regarding particular drugs

Table S7 Mixing two or more drugs in microset without considering interactions

Table S8 Infusing drug faster than should be infused

Table S9 Intravenous injection of subcutaneous drug

Table S10 Subcutaneous injection of intravenous drug

Table S11 Intramuscular injection of intravenous drug

Table S12 Intravenous injection of intramuscular drug

Table S13 Administering biting sublingual drug to be swallowed

Table S14 Administering several oral drugs simultaneously

Table S15 Administering painkiller without doctor's order

Table S16 Administering the wrong drug

Table S17 Administering drug more/less than prescribed dose

Table S18 Administering drug without a defined route

Table S19 Not considering appropriate position of patient based on type of drug

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