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The relationship between medication errors and nurses' work environment

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ABSTRACT

Background: Providing safe care is one of the nursing objectives and medication error is considered as a threatening factor for patient safety. The current study was conducted to determine the relationship between the medication errors and nurses' work environment.

Methods: This cross-sectional, correlational study was performed on nurses working in hospitals affiliated to Tehran University of Medical Sciences, Tehran, Iran, in 2012. A total of 300 nurses were selected through stratified sampling method. Data were collected using a personal information form, Nurses' Work Environment scale, and medication errors questionnaire. To analyze the data, Pearson product-moment correlation coefficient, Kruskal–Wallis, and independent t-test were run, using SPSS16.

Results: The mean score of medication errors of nurses was 15.12±4.14 and the mean score of nurses work environment index was 67.34±5.6. Most types of reported medication errors were associated with medication administration later or sooner than the scheduled time (24%), lack of necessary measures before medication administration (17.4%), and non-compliance with the time of medication administration (10.9%). The nurse-physician relationship was reported as the most adverse aspect in context of work environment. There was a significant negative relationship between the occurrence of medication errors and work environment (P<0.016, r=-0.8).

Conclusion: Based on the study results, as nurses' working conditions improve, the rate of medication errors is lowered. Thus, application of effective strategies by managers for improving work conditions, and in turn, providing safe care for patients is of great significance.

1. Introduction

Patient safety is one of the critical aspects of care quality enhancement that can affect patients' health.[1] This concept is considered a top priority in treatment and care systems in developed countries.[2, 3] In fact, safety means preventing unintended errors and incidents while providing patients health care services.[4] Among the factors related to patient safety, diagnosis, medication administration, and blood transfusion errors, as well as falls and suicide are recognized as indicators of the health care quality due to their high incidence rates and potential risks.[5, 6] Medication errors are preventable events occurring during the treatment process and leading to some adverse events such as wrong drug administration.[7]

According to former studies, annually 7,000 people are estimated to die of medication errors in the USA and this problem costs 77 million dollars a year.[8] Studies performed in Europe revealed that 19-28% of in-patients experience medical errors.[9, 10] In Iran, however, different studies reported disparate percentages for medication errors. Some studies propose that lack of real statistics on medication errors, which is very alarming, is due to inaccurate reporting of health care errors.[11, 12]

Medication errors can happen at any stage of medication administration, but high percentage of these types of errors is attributed to wrong drug prescription or route of administration.[13] Hajibabaee et al. (2011) pointed out that nurses can prevent 58% of medication errors; nonetheless, drug administration errors, which account for 28% of the total errors, usually occur by nurses.[14] The results of

some studies confirm the prevalence of medication errors by nurses in Iran. Penjoveini (2007) reported the prevalence rate of medication errors made by nurses in Sanandaj to be about 16.7%.[15] Hajibabaee et al. (2011) reported 19 cases of medication errors in the hospitals affiliated to Iran University of Medical Sciences within three months,[14] and Yousefi et al. (2015) reported this type of error to be 31.6% in hospitals affiliated to Shahid Beheshti University during one month.[13]

To prevent medication errors, the five pillars of medication administration should be carefully observed, which include the right patient, drug, administration route, time, and dose.[16] Nowadays, types of drugs and patients taking multiple medications have increased. In addition, to prevent complications, it is mandatory to examine the physical and biochemical conditions of patients and to provide patients with proper training at any treatment stage. In fact, nurses are accountable for providing patient safety that goes beyond the "five pillars" principle.[14]

In addition to the impact of nurses on occurrence of health care errors, two other main factors, namely management and ward, are suggested to affect this problem;[17, 18] accordingly, working conditions could partly cause nursing errors.[19, 20] Amaral et al. (2014) also indicated that providing appropriate organizational and environmental conditions can help nurses deliver high-quality care based on the established professional standards. Work environment can contribute to or hinder the nursing profession.[21] Shishegaran and Mahjoub (2012) noted that only 59% of nurses were satisfied with their work environment.[22] In a study by Clarke (2007) conducted in Pensylvania, USA, the majority of nurses described their work environment as really desirable;[23] however, in a study by Liu et al. (2012), only 40% of nurses were satisfied with their work environment.[24] Considering the disparate reports on the rate of medication errors and working conditions of nurses and given the high prevalence of medication errors, which threaten patient safety, accurate and comprehensive identification of the factors affecting medication errors is of utmost importance.

2. Methods

2.1. Design

This cross-sectional, correlational study was performed on nurses working in hospitals affiliated to Tehran University of Medical Sciences, Tehran, Iran, during 2012.

2.2. Participants and setting

In this study, To determine the standard sample size at 95% confidence level and statistical power of 90%, the correlation coefficient between the rate of medication errors and any of the nurses' work environment variables was assumed to be at least 0.15 (to be statistically significant). Using the sample size formula ($d= 0.2$, $Z_{1-\beta}= 1.28$, $Z_{1-\alpha/2}$) the standard sample size was calculated to be 265, but considering subject loss, 300 participants were recruited. The inclusion criteria comprised of having at least associate degree of nursing and at least one year of work experience in hospitals affiliated to Tehran University of Medical Sciences.

In general, 300 nurses were selected through stratified sampling method. For the purpose of sampling, out of 27 hospitals affiliated to Tehran University of Medical Sciences, 13 hospitals with the highest number of nurses and patients in specialized wards were selected. Afterwards, a list containing the total number of nurses (official and contractual employees) working in the 13 selected hospitals was prepared and the subjects were randomly selected based on this list.

$$\frac{\text{Total number of nurses working in X hospital}}{\text{Total number of nurses working in the selected hospitals}} \times 500$$

2.3. Instruments

In general, three data collection instruments were applied. The first one was related to nurses' personal information such as age, gender, marital status, employment status, educational level, work unit, typical shift work, and experience in the nursing profession.

The second questionnaire was the Practice Environment Scale of the Nursing Work Index designed by Lake in 2002.[25] This questionnaire gauges nursing practice environment. After obtaining permission from the questionnaire designer through e-mail, it was back-translated, that is, the English questionnaire was matched with the original one, and after checking the translation, the questionnaire was translated into Persian. Nursing Working index questionnaire consists of 25 items with five subscales including participation in hospital affairs (5 items), nursing role in improvement of quality of care (10 items), management and leadership ability and support (4 items), staffing and resource adequacy (3 items), and nurse–physician relationship (3 items). This questionnaire was rated using a 5-point Likert scale (i.e., 1 strongly disagree, 2 disagree, 3 no idea, 4 agree, and 5 strongly agree). The minimum and maximum possible scores

from this questionnaire are 25 and 125; scoring 25-75 means an optimum work environment and scoring 76-125 indicates an undesirable working environment.

The third questionnaire was a self-designed scale examining the prevalence of medication errors. After reviewing the literature and investigating the related tools, 14, 16 this 11-item questionnaire was designed. This questionnaire was filled out in form of a self-report (never, yes, and the number of errors) by the nurses and examines the prevalence of medication errors within three months prior to initiation of the study.

In order to determine the content validity of both questionnaires (Nursing Work Index and medication errors scale), they were given to 12 faculty members of Tehran University of Medical Sciences (9 Nursing PhDs and 3 Biostatistics PhDs). For final revision, the modified scale was presented to three faculty members, who had sufficient expertise in the field, and the suggested corrections were applied. To check the reliability of the tools, internal consistency of the questions was assessed in both questionnaires using Cronbach's alpha coefficient. The questionnaires were administered to 30 nurses, who had the same demographic information; these nurses were ultimately excluded from the study. The coefficients were estimated to be 0.89 and 0.78 for the Nursing Work Index and medication errors questionnaires, respectively.

2.4. Data Collection

The participants were given the questionnaires; the nurses were required to fill out the questionnaires about the patients whom they were taking care of during in the past three months using self-report method; the questionnaires were collected 3-7 days later.

2.5. Ethical considerations

After obtaining a letter of introduction from Ethics Committee of Tehran University of Medical Sciences and presenting it to the hospital authorities, the study objectives were described for all the participants. Regarding the Declaration of Helsinki, this study tried to observe the ethical principles in clinical studies such as confidentiality of the data, attention to consent, anonymity, and lack of conflicts of interest.

2.6. Statistical analysis

Data were analyzed using descriptive statistics (mean and standard deviation), Pearson product-moment correlation coefficient (to evaluate the correlation between work environment of nurses and medication errors), independent t-test (to compare mean difference of medication errors and two-level variables such as gender and marital status according to the normal distribution of data), and Kruskal-Wallis (to compare the mean difference of medication errors with variables having more than two levels such as employment status, educational level, usual shift work, work unit, age, and experience according to the normal distribution of data) through SPSS version 16. P-value less than 0.05 was considered statistically significant.

3. Results

Table 1 demonstrates the demographic information of the participants. According to the results, the mean score of medication errors during three months before the study was 4.14±15.12. The most frequent reported errors were administering drugs sooner or later than the scheduled time (24%), not taking necessary measures before drug administration (17.4%), and wrong time of drug administration (10.9%) (Table 2).

The mean score of the nurses' work environment was 67.34±5.6, indicating that the work environment was desirable from the participants' point of view. According to the nurses' reports, the most undesirable work environment condition was associated with nurse-physician relationship (86.13±3.16) and staffing and resource adequacy (53.31±7.76) (Table 3). Pearson product-moment correlation coefficient test reflected that there was a negative correlation between the medication errors and nursing work environment (P=0.016, r=-0.8) (Table 4).

Table 1. Demographic characteristics of participants

Variable		No.(%)
Gender	Male	4(13.3)
	Female	260(86.7)
Marital status	Single	108(36)
	Married	192(64)
Employment status	Official	80(26.7)
	Contractual	170(56.6)
	Apprenticeship	38(12.7)
	Short-term contract	12(4)
Educational level	Associate degree	5(1.7)
	Bachelor	289(96.3)
	MSc and PhD	6(2)
Usual shift work	Morning	60(20)
	Evening	10(3.3)
	Night	7(2.3)
	Rotational	223(74.4)
Work unit	Emergency	25(8.41)
	Children	16(5.3)
	CCU*	21(7)
	ICU**	67(22.3)
	Internal medicine	53(17.66)
	Operation room	24(8)
	Surgery	94(31.33)
Age(years)	M ± SD	32±6.14
Job experience (years)	M ± SD	7±6.034

*critical care unit **intensive care unit

Table 2. Medication error frequency

Medication errors in the last three months	No.(%)
Administering drug sooner or later than the scheduled time	40(24)
Wrong time of drug administration (before or after meal)	18(10.8)
Not taking necessary measures before administration of drugs, which requires special attention (checking pulse, blood pressure, etc.)	29(17.4)
Mixing two or more drugs regardless of drug interactions in microset	17(10.2)
The rapid injection of a drug that must be injected slowly	14(8.4)
Administering multiple oral drugs together	13(8)
Wrong route of administration (intravenous administered intramuscularly, subcutaneous administered intravenously, intravenous administered subcutaneously, intramuscular administered intravenously)	13(8)
Swallow administration of sublingual or chewing drugs	10(6)
Not following any specific route of administration	5(3)
Giving sedatives without prescription	4(2.4)
Administering medications more or less than the prescribed dose	3(1.8)
Total	166(100)
M±SD	15.12±4.14

Table 3. Frequency and mean of the scores of nurses' work environment questionnaire

Work Environment Index	Desirable No.(%)	Undesirable No.(%)
The nurses have the opportunity to participate in decision-making.	93(31)	207(69)
The nurses have advancement opportunities.	104(34.6)	196(63.6)
The authorities listen to the concerns of nurses and feel responsible about them.	193(64.3)	107(35.6)
It is easy for nurses to access director of nursing.	207(69)	93(31)
Director of nursing has equal power and authority over hospital affairs as other levels of management in the hospital.	35(11.6)	256(88.3)
Total (M±SD)	41.11±4.21	
There is the possibility of nursing diagnosis.	39(13)	261(87)
The quality assurance program is active.	261(71.7)	39(28.3)
There is orientation and clinical training for the newly hired nurses.	292(97.3)	8(2.6)
Delivering care is based on nursing model rather than the physician model.	287(95.7)	13(4.3)
Day to day continuity of care is possible for each patient.	283(94.3)	17(5.7)
There is a clear philosophy for patient care in the caring environment.	250(83.3)	50(16.6)
Care plan is developed for all patients on a daily basis.	293(97.6)	7(2.4)
Management expects high standards of care from nurses.	295(98.3)	5(0/7)
There are ongoing and consistent trainings for the nurses.	263(87.6)	37(12.4)
It is possible to work with nurses who have clinical merits.	298(99.7)	2(0.03)
Total (M±SD)	53.24±2.58	
Director of nursing is a good manager and leader.	153(51)	147(49)
Nurses are involved in management decision-makings even if it is in conflict with doctor's opinion.	39(13)	261(87)
Supervisor uses mistakes as an opportunity to learn and not to blame.	163(54.3)	137(45.7)
Good work is recognized and appreciated.	175(58.3)	125(41.7)
Total (M±SD)	38.11±3.64	
There are sufficient nursing resources to provide quality care.	39(13)	261(87)
Having adequate support services allows me to allocate more time to my patient.	129(43)	171(57)
There is enough time to discuss the patients' problems with other nurses.	261(87)	39(13)
Total (M±SD)	53.31±7.76	
There are a lot of teamwork between nurses and physicians.	69(23)	231(77)
There is a good relationship between the nurses and physicians.	138(46)	162(54)
There is mutual respect between the nurses and physicians.	117(39)	183(61)
Total (M±SD)	86.13±3.16	
Total score of Work Environment Index (M±SD)	67.34±5.6	

Table 4. Mean score of medication error based on work environment

Medication error	Favorable M±SD	Unfavorable M±SD	*P-value
Administering drug sooner or later than the scheduled time	8±3.2	32±2.4	r= -0.8, P=0.007
Wrong time of drug administration (before or after meal)	3.1±1.1	15±0.23	r=-0.7, P=0.006
Not taking necessary measures before administration of the drugs, which require special attention (checking pulse, blood pressure, etc.)	12±1.4	17±0.54	r=-0.5, P=0.01
Mixing two or more drugs regardless of drug interactions in microset.	2±0.24	15±0.32	r=-0.7, P=0.002
The rapid injection of a drug that must be injected slowly	4±0.89	10±0.23	r=-0.4, P=0.04
Administering multiple oral drugs together	4±3.3	9±0.65	r=-0.6, P=0.04
Wrong route of injection (intravenous administered intramuscularly, subcutaneous administered intravenously, intravenous administered subcutaneously, intramuscular administered intravenously)	3±0.56	10±1.3	r=-0.6, P=0.002
Swallow administration of sublingual or chewing drugs	2 ± 4.6	8 ± 0.87	r = -0.7, p = 0.009
Not following any specific route of administration	1 ± 0.23	4 ± 1.3	r = -0.6, P=0.02
Giving sedatives without doctor's prescription	1±0.45	3±4.6	r=-0.5, P=0.02
Administering drug more or less than the prescribed dose	1±3.6	2±2.4	r=-0.3, P=0.04
Total number of medication errors	3.84±2.05	11.42±1.06	r=-0.8, P=0.016

*Pearson Correlation

4. Discussion

The results of this study showed that better nursing work environment results in lower frequency of medication errors. A study conducted in Michigan, USA, on nurses in an intensive care unit in 2007 indicated a significant negative correlation between physicians-nurses relationship and the incidence of medication errors during care delivery.[26] Although the mentioned study was carried out only in intensive care units and emphasized physicians-nurses relationship, its findings are consistent with the findings of this study.

Armsrong and Laschinger (2006) stated that patient safety culture can be improved through enhancing the nursing work environment quality.[27] Flynn et al. (2012) also mentioned that a positive and supportive environment can have a positive impact on patient safety and error reduction.[28] Despite the differences in methodology, context, and sample size in the aforementioned study, its results are in line with the findings of this study.

In the current study, 15.12 cases of medication errors were reported for each nurse during three months. This amount of errors during three months is alarming and necessitates attending to this problem. There is no measure for quality and type of error and just the frequency of errors can be compared.

In the study by Hajibabaee et al. (2011), the mean score of errors was reported to be 5-19 cases during three months;[14] the difference between their study and the current one is that they investigated the incidence of medication errors only in Medical-Surgical, Orthopedics, Obstetrics, and Gynecology wards, but in this study, all the hospital wards were evaluated in terms of incidence of medication errors.

In Penjoveini's study (2007), the frequency of medication errors in Sanandaj hospitals was estimated to be 16.7%,[15] which is not consistent with our results. This discrepancy might be due to the different sample sizes as the sample size (n=104) of the Penjoveini's study was one third of that of the current study; accordingly, more error incidents were estimated. Moreover, this difference may be owing to the method of data collection in Penjoveini's study; Penjoveini employed just one scale examining the 'five pillars' of drug administration, which was filled out by the researcher after observing drug administration to patients, whereas in the current study, data collection was carried out through self-report and recalling events methods during three months. Thus, some factors such as disclosure of personal information, being under the influence of colleagues, and the participants' inclination to assess themselves better than they are in reality can lead to lower error reporting.

Mrayyan et al. (2007) examined medication errors in Joradn. Despite using a larger sample size than the present study, they reported the medication errors for each nurse to be 2.2 during three months,[29] which is significantly different from our finding. Perhaps the inconsistency between the mean of medication errors in Iranian studies,

including the current study, is due to particular conditions such as lack of human resources according to the standards of care system. Similarly, Panjoveini (2007) indicated that nurses' workload and increasing number of patients in proportion to the nurses might influence the rate of medication errors.[15]

The most frequent errors were found to be administering drugs sooner or later than the scheduled time, not taking the necessary measures before drug administration, and wrong time of drug administration (before or after meal). Likewise, Seki and Yamazaki (2006) reported the wrong time of drug administration as the most frequent error.[30] Barker et al. (2002) showed that the highest percentage of errors in Colorado, USA, was associated with errors in medication administration, drug elimination, and administration of wrong dose,[31] which is in line with the findings of this study. Likewise, in Penjoveini's study (2007), medication error frequency was related to drug elimination and administration of wrong doses in some cases.[15]

The results of this study showed that the work environment was desirable from nurses' point of view. Similarly, in Clarkes' study (2007), which was conducted in Pennsylvania, USA, work environment was reported to be highly desirable from the nurses' perspective. In that study, Clarke concluded that when nurses are satisfied with the nurse-physician relationship and adequacy of resources fewer errors occur.[23]

According to our findings, the most undesirable work environment conditions were associated with the nurse-physician relationship and adequacy of resource and staffing. The relationship between insufficient resources and error incidence shows the importance of staffing and resources adequacy in the prevention of medication errors. Tervo Heikkinen et al. (2008) reported a statistically significant relationship between work environment and nurses' unintended care errors and shortage of human resources.[32] Similarly, the current study found inadequate human resources as an important factor leading to incidence of medication errors.

The results of Manjlovich and DeCicco' study (2007) revealed that the interaction between physicians and nurses is an important predictor of medication errors incidence, and when nurses hold a positive attitude toward the c their work environment and their relationship with physicians, care errors would be diminished and patient safety would be improved.[26]

According to the Agency for Health Care Research and Quality (2007), the reasons for occurrence of clinical errors, which threaten patient safety, are communication difficulties at work, lack of teamwork, inadequate information, patient-related issues (patient evaluation and training), problems in organized transfer of information, technical failures, and inappropriate planning.[33] In addition to these factors, appropriate equipment and facilities based on patients' and nurses' needs might influence the effectiveness and adequacy of programs and services.

One of the limitations of the study was using self-report method for data collection as the process of completing the questionnaire might be affected by other factors such as the disclosure of personal information, being affected by the colleagues, the participants' inclination to assess themselves better than reality. In addition, data was collected during a short period, which makes the examination of causal relationships impossible.

5. Conclusion

Given the inverse relationship between the work environment and medication errors and since nurses work with humans who need enduring and compassionate care, the nurses' physical and mental health in the work environment is tremendously significant and its improvement can enhance the quality of safe care. Nurses can ensure patient safety when the required foundations are laid. Thus, nursing directors should be aware of the factors affecting patient safety. Regarding the low generalizability of this study, it is recommended to conduct more studies with larger sample sizes.

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions

Soodabeh Joolaee: contributed with monitoring the study administration and writing thearticle. Mahboobeh Shali: conducted the study and wrote the first draft. Abbas Hooshmand: participated in data analysis and writing the paper. Sara Rahimi: helped with data colletion. Hamid Haghani: was the statistical consultant and contributed with drafting the article.

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