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Relationship Between Pharmaceutical Knowledge and Probability of Medication Errors Among Nurses: A Cross-sectional Study in the Northwest of Iran in 2020

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Abstract

Background: Patient safety is a major concern for health care professionals. Medication errors have been considered a major indicator of health care quality. The lack of pharmacological knowledge is a cause of medication error among nurses.
Objectives: The purpose of this study was to investigate the relationship between pharmacological knowledge and the probability of medical errors in nurses working in Urmia hospitals in 2020.
Methods: This cross-sectional study included 490 nurses randomly selected from among those working in hospitals of Urmia in 2020. The data collection tool was a multiple-choice questionnaire about knowledge and pharmacological skills consisting of 3 sections: demographic information, nurses' drug knowledge, and the confidence level of response in nurses. To analyze questions and hypotheses via SPSS version 21, the *t*-test and analysis of variance (ANOVA) were employed.
Results: The highest pharmaceutical knowledge scores of nurses were related to methods of administration (2.9 ± 1.01 [72.56%]), and the lowest score was related to drug management (1.05 ± 0.63 [52.84%]). The mean of error probability was very low in 28.81% of nurses, low in 37.66%, high in 11.34%, and very high in 22.85%. Pharmaceutical knowledge had a significant relationship with gender, wards, type of hospital, and number of children ($P < 0.05$ for all).
Conclusions: Since the nurses' level of pharmaceutical knowledge has an important role in the correct prescription of medicine, we suggest that nurse managers and educational supervisors in the field of nursing use in-service training programs and prepare training booklets and posters to promote nurses' pharmaceutical knowledge in this field.

Keywords: Pharmaceutical Knowledge, Medication Errors, Patient Safety

1. Background

Patient safety is a major concern for health care professionals (1, 2). Therefore, in today's health care system, patient safety is a key concept and an important indicator of quality control of services (3). There are various definitions of patient safety. The best description for patient safety is to prevent the development of injury in patients due to errors in performing an action. This definition includes the consequences of diagnostic and therapeutic factors, as well as the usage rate of health care resources. Patient safety is person-centered, and caring for patients without harm is an ethical principle (4). Medical errors are among the major challenges and threats to the health system in all countries (5, 6). Some studies in Iran have shown that larger hospitals account for more than half of all medical errors (7). Notably, nurses (67.3%) and physicians (20.2%) commit the majority of errors in hospitals in Iran (8, 9). The high rate of medical errors in some hospitals in Iran confirms the mentioned challenge (8).

According to studies by Johns Hopkins University in 2018, the latest medical error statistics show 250000 cases per year in the United States (10). Medical errors after heart disease and cancer are the third leading cause of death in the United States (11). Medication error is a major determinant of health care quality among safety issues (namely, patient identification, error in blood transfusions, falls, and suicide) (5). Drug errors refer to any preventable event during the drug treatment process, which can lead to misuse of medication or harm to the patient (12). Drug errors may occur at any stage of the therapeutic process, such as writing and copying prescriptions, distributing and dis-

pensing medication, and during the delivery of medication to the patient (13). Medication errors result in adverse outcomes, such as increased mortality, length of hospitalization, and treatment costs for patients (14). According to a 2005 study, thousands of people in the United States die every year from medication errors, and financial costs related to drug side effects in this country are close to 77 million $ per year (15). Bates et al. reported that patients experience at least 1 medication error during their hospitalization (16).

Practical application of error probability criteria focuses on all safety measures, including error probability identification and assessment, as well as error reduction and elimination (17). The first step in evaluating the probability of error is to define the objectives of the assessment (18), which is an important part of hospital management and patient safety (19). Reducing the probability of error in hospitals is vital to improve the quality of health care and achieve effective communication between hospital staff and patients (20, 21). In this regard, identifying the causes of errors and awareness of the challenges associated with reducing them are the first step in implementing strategies to decrease unwanted events (22).

Pharmaceutical knowledge is an important component of a nurse's clinical practice (23). Nurses spend approximately 40% of their working time in hospitals to give medication to patients (24). Reasons for the increasing importance of pharmacology knowledge for nurses are as follows: Medications are generally administered by nurses, patients' medication regimens are constantly changing and may include new medications, nurses need medical knowledge to educate patients about medications and their side effects with changing demographics conditions, and the population of patients taking more than 1 drug is increasing (25).

2. Objectives

In this study, the researcher attempted to evaluate the relationship between pharmacology knowledge and the probability of medical errors in nurses working in Urmia hospitals in 2020.

3. Methods

The methodology of the present study is based on the strengthening the reporting of observational studies in epidemiology (STROBE) checklist (26). The local human subject review board of Urmia University of Medical Sciences approved this study (code: IR.UMSU.REC.1397.203). Urmia is a city located in the northwest of Iran bordering Turkey, Iraq, and the Nakhchivan Autonomous Republic. In the present cross-sectional study, a random sample of 490 nurses from those working in different wards of private and public hospitals of Urmia City were investigated in 2020. Due to the wide range of pharmaceutical knowledge in nurses, an average of 50% was considered. The sample size was selected based on the study by Simonsen et al. (27) as follows:

$$
\begin{aligned}
n &= \frac{z_{1-\frac{\alpha}{2}}^{2} \times pq}{d^2} \\
&= \frac{1.96^2 \times 0.5 \times 0.5}{0.045^2} \\
&= 475
\end{aligned}
$$

The sample size was 475 people, and, considering the percentage of dropout, 490 nurses working in hospitals of Urmia City were selected and examined based on the total number of nurses in that center. Before distributing the questionnaires, we obtained the informed consent form from them.

The data collection tool in this study was a multiple-choice questionnaire based on the study by Simonsen et al. (27, 28) on pharmacology knowledge and skills, consisting of 3 sections. The inclusion criteria in the present study were being employed in one of the hospitals in Urmia and signing an informed consent form. The first section included demographic information of nurses (such as age, gender, marital status, number of children, education, clinical experience, place of work, history of drug training courses, ward type, shift work, and overtime work rate per month), the second section included nurses' medical knowledge (ie, pharmacology information, drug side effects, prescription method, storage, preparation and drug management, patient prescription, and pharmaceutical computing), and the third section was the confidence level of nurses' response. The reliability of the questionnaire was calculated to be 0.8 using the Cronbach α coefficient.

3.1. Data Analysis

Statistical analyses were conducted using SPSS version 21 (IBM Inc, Armonk, NY, USA). Quantitative measurement was expressed by mean $\pm$ SD. Qualitative variables were presented as absolute frequency and percentage. To analyze questions and hypotheses, the *t*-test and analysis of variance (ANOVA) were employed. P-values less than 0.05 were regarded as statistically significant.

4. Results

A total of 490 nurses were enrolled in this descriptive cross-sectional study working in 9 hospitals of Urmia City in 2020. The characteristics of the nurses are presented in Table 1.

Table 1. Sample Characteristics of 490 Nurses

Variables	No. (%)
Gender	
Female	411 (83.9)
Male	79 (16.1)
Education	
Technician	1 (0.2)
Bachelor of sciences	472 (96.3)
Master of science	17 (3.5)
Marital status	
Single	181 (36.9)
Married	307 (62.7)
Divorced	2 (0.4)
Drug training class	
In the last 6 months	270 (55.1)
In the past 1 year	133 (27.1)
More than a year	87 (17.8)
Wards	
General	274 (55.9)
Special	216 (44.1)
Morning	108 (22)
Shift work	
Evening	13 (2.7)
Night	3 (0.6)
Circulation	366 (74.7)
< 50	147 (30)
50 - 100	252 (51.4)
Overtime work (h)	
100 - 150	69 (14.1)
> 150	22 (4.5)
Type of hospital	
Public	424 (86.5)
Private	66 (13.5)
Number of children	
0	256 (52.2)
1	109 (22.2)
2	118 (24.1)
3	7 (1.4)
20 - 30	205 (41.83)
31 - 40	190 (38.77)
Age (y)	
41 - 50	89 (18.16)
> 50	6 (1.2)
< 10	282 (57.55)
Clinical experience (y)	
11 - 20	182 (37.14)
> 20	26 (5.30)

4.1. Pharmaceutical Knowledge Scores

Table 2 illustrates the pharmaceutical knowledge scores of nurses. The highest pharmaceutical knowledge scores of nurses were related to the method of administration (2.9 ± 1.01 [72.56%]), and the lowest score was related to drug management (1.05 ± 0.63 [52.84%]).

4.2. Confidence in Response Scores

Table 3 shows the confidence in response scores among nurses. The highest score of confidence was related to storage response (11.33 ± 4.03 [70.82 ± 25.1%]), and the lowest score was related to medicinal effects (7.71 ± 2.84 [64.26 ± 23.67%]).

4.3. The Relationship Between Pharmaceutical Knowledge and Confidence in the Response with Probability of Medication Errors Among the Nurses

According to Table 4, the mean of correct answers was 60.44%, and only 28.81% of nurses had confidence in their response. Therefore, the mean of error probability was very low in 28.81% of nurses, low in 37.66%, high in 11.34%, and very high in 22.85%. Considering the inverse relationship between the mean of medication errors and confidence in the response in each of the mentioned dimensions, the lowest and highest probability of medication error was in storage (34.8%) and adverse effects (20.4%), respectively. The relationship between pharmaceutical knowledge and confidence in the response for all the remaining dimensions was significant except for side effects and drug management ($P < 0.05$ for all).

4.4. The Relationship Between Pharmaceutical Knowledge and Confidence in the Response with Some of the Demographic Characteristics in Nurses

According to Table 5, pharmaceutical knowledge had no significant relationship with education, marital status, drug training courses, shift work, overtime work, age, and clinical experience ($P > 0.05$ for all); however, this relationship was statistically significant for the remaining factors ($P < 0.05$ for all).

The findings in Table 5 also show that confidence in the response had no significant relationship with education, drug training courses, and overtime work ($P > 0.05$ for all), but this relationship was significant for the other investigated factors ($P < 0.05$ for all).

5. Discussion

Medication errors constantly occur over time (29). The efforts to reduce and control these errors depend on taking

Table 2. The Pharmaceutical Knowledge Scores of Nurses

Dimension	Number of Questions	Mean Scores of Pharmaceutical Knowledge	Pharmaceutical Knowledge (%)
Pharmacology	3	1.96 ± 0.81	65.4 ± 27.3
Medicinal effects	3	1.72 ± 0.86	57.5 ± 28.99
Side effects	4	2.8 ± 1.00	70 ± 25.18
Method of administration	4	2.9 ± 1.01	72.56 ± 25.31
Drug management	2	1.05 ± 0.63	52.84 ± 31.64
Storage	4	2.26 ± 0.84	56.60 ± 21.22
Preparation	4	2.42 ± 0.87	60.72 ± 21.99
Prescription to the patient	4	2.15 ± 0.84	53.93 ± 21.16
Pharmaceutical calculations	14	8.78 ± 3.06	62.76 ± 21.86
Total	42	24.58 ± 5.54	58.51 ± 13.19

Table 3. Confidence in Response Scores in Nurses

Dimension	Number of Questions	Mean of Scores	Confidence in Response (%)
Pharmacology	3	7.93 ± 2.73	66.12 ± 22.81
Medicinal effects	3	7.71 ± 2.84	64.26 ± 23.67
Side effects	4	11.12 ± 3.7	69.5 ± 23.16
Methods of administration	4	10.45 ± 3.75	65.34 ± 23.49
Drug management	2	5.61 ± 2.09	70.2 ± 26.13
Storage	4	11.33 ± 4.03	70.82 ± 25.1
Preparation	4	11.06 ± 3.89	69.17 ± 24.33
Prescribing to the patient	4	11.14 ± 4.18	69.65 ± 26.18
Pharmaceutical calculations	14	38.10 ± 1.41	68.06 ± 25.23
Total	42	114.49 ± 36.97	68.14 ± 22

Table 4. The Relationship Between Pharmaceutical Knowledge and Confidence in the Response and the Probability of Medication Errors in Nurses [a]

Dimension	Pharmaceutical Knowledge		Confidence in the Response				P-Value
	Correct	False	Very Much	Much	Low	Very Low	
Pharmacology	64	34.5	21.8	42.3	14.5	21.3	< 0.001
Medicinal effects	56.4	41.9	20.45	40.6	14.5	24.4	< 0.001
Side effects	69.2	29.9	29.5	39.3	18.1	20.4	0.398
Methods of administration	71.3	26.9	23.7	37.8	14.5	23.8	< 0.001
Drug management	51.6	46.5	33.6	35.6	8.8	21.9	0.065
Storage	55.5	42.9	34.8	35.2	8.3	21.6	< 0.001
Preparation	60.3	38.8	28.9	41.1	7.4	22.4	< 0.001
Prescribing to the patient	53.3	45.5	33	35.5	8.2	23.1	0.009
Pharmaceutical calculations	62.0	35.5	33.6	31.6	7.8	26.8	< 0.001
Mean	60.4	38.0	28.8	37.6	11.3	22.8	< 0.001

[a] Values are expressed as percent.

Table 5. The Relationship Between Pharmaceutical Knowledge and Confidence in the Response with Some of the Demographic Characteristics in Nurses

Variables	Pharmaceutical Knowledge	P-Value	Confidence in the Response	P-Value
Gender		0.002		0.018
Female	24.72 ± 5.15		115.76 ± 36	
Male	23.85 ± 7.22		107.89 ± 41.05	
Education		0.983		0.680
Technician	25		133	
Bachelor of science	24.58 ± 5.46		114.22 ± 37.1	
Master of science	24.35 ± 7.75		120.82 ± 34.42	
Marital status		0.068		< 0.001
Single	25.03 ± 5.1		110.49 ± 40.4	
Married	24.3 ± 5.78		117.06 ± 34.11	
Divorced	27 ± 2.8		81.5 ± 55.86	
Drug training class		0.316		0.150
In the last 6 months	24.91 ± 5.17		116.98 ± 36.11	
In the past 1 year	24.05 ± 6.05		113.5 ± 35.84	
More than a year	24.37 ± 5.97		108.24 ± 40.73	
Wards		0.001		< 0.001
General	24.01 ± 6.18		110.44 ± 39.27	
Special	25.3 ± 4.5		119.63 ± 33.2	
Shift work		0.316		0.040
Morning	25.19 ± 4.92		122.98 ± 34.69	
Evening	23.69 ± 7		104.15 ± 44	
Night	20.33 ± 8.62		125 ± 15.52	
Circulation	24.46 ± 5.63		112.26 ± 37.17	
Overtime work (h)		0.585		0.410
< 50	24.18 ± 6.27		116.93 ± 37.48	
50 - 100	24.66 ± 5.31		112.26 ± 35.44	
100 - 150	24.71 ± 4.92		118.91 ± 39.06	
> 150	25.82 ± 4.67		109.86 ± 43.75	
Type of hospital		< 0.001		0.035
Public	25.24 ± 4.91		118.44 ± 34.61	
Private	20.3 ± 7.21		89.12 ± 41.58	
Number of children		0.007		0.026
0	24.87 ± 5.47		110.37 ± 39.96	
1	23.41 ± 6.1		114.88 ± 34.7	
2	24.95 ± 5.16		122.48 ± 30.62	
3	25.71 ± 2.28		124.29 ± 38.16	
Age (y)		0.246		< 0.001
20 - 30	24.36 ± 5.97		107.73 ± 39.07	
31 - 40	24.4 ± 5.04		116.71 ± 35.07	
41 - 50	25.3 ± 5.64		124.07 ± 34.01	
> 50	27 ± 2.6		133 ± 20.42	
< 10	24.45 ± 5.7		109.39 ± 39.18	
Clinical experience (y)		0.250		< 0.001
11 - 20	24.65 ± 5.13		120.55 ± 32.75	
> 20	25.42 ± 6.59		127.35 ± 31.26	

a systematic approach to the underlying factors and eliminating these causes as much as possible (30). Based on the findings of the present study, the mean score of pharmaceutical knowledge in nurses working in hospitals in Urmia City was 24.58 ± 5.54 (58.51 ± 13.19%), whereas the average nurses' knowledge of medication in the study by Simonsen et al. was 65% (27). The highest pharmaceutical knowledge scores of nurses were related to the method of administration, and the lowest score was related to drug management. In Norway, the highest pharmaceutical knowledge scores of nurses were related to pharmaceutical calculations, and the lowest scores were related to drug storage (27).

Our findings were in line with those of Barber et al. (31), Greengold et al. (32), and Elliott et al. (33), showing that mean medication error probability was very low in 28.81% of nurses, low in 37.66%, high in 11.34%, and very high in 22.85%. In agreement with this finding, the mean medication error probability in some previously published studies has been reported to be > 50% (14, 34, 35). This discrepancy may be due to differences in the sample size that causes a random error.

According to Table 4, the mean of correct answers was 60.44%, and only 28.81% of nurses had confidence in their response. Therefore, the mean of error probability was very low in 28.81% of nurses, low in 37.66%, high in 11.34%, and very high in 22.85%. Given the inverse relationship between the mean of medication errors and confidence in the response in each of the mentioned dimensions, the lowest probability of medication errors was in drug storage (34.8%), and the highest probability was observed in adverse effects (20.4%). The relationship between pharmaceutical knowledge and confidence in the response for all remaining dimensions was significant except for side effects and drug management.

Our findings indicated that pharmaceutical knowledge had no significant relationship with education, marital status, drug training courses, shift work, overtime work, age, and clinical experience, but this relationship was significant for the other investigated factors. Previous studies consistent with our results have demonstrated a significant difference between pharmaceutical knowledge and gender (35), hospital ward, and number of children (36). We also found no significant relationship between overtime work and the probability of medication errors.

Inconsistent with our results, Souzani et al. reported that overtime work was one of the most important reasons for medication errors in nurses (37). According to the results of their study, the pharmacological knowledge of nurses was 58.51%, but in the study by Ndosi and Newell, this rate was calculated at a higher level (88%) (25). This result indicates that the pharmacological knowledge of nurses in the present study is not sufficient and that nurses need further training in this regard. Many researchers have also stated that increasing pharmacological information and updating nurses' information about medications can significantly reduce medication errors (38, 39). The present study did not face any particular limitations. The results of the present study are expected to be used in various fields, such as services, education, and nursing research.

5.1. Conclusions

The results of the present study are expected to be used in different areas, such as nursing services, education, and research. Since the nurses' pharmaceutical knowledge level plays an essential role in the correct administration of medications, it is suggested that nurse managers and supervisors improve nursing knowledge by holding in-service training courses and providing booklets and posters.

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Footnotes

Authors' Contribution: Conceived and designed the analysis: E. D. and R. B. Data collection: H. HS. and H. S. Data analysis: H. HS. and H. S. Drafting of the manuscript: E. D. and R. B. All authors contributed to and reviewed the final version of the manuscript. All the authors met the criteria of authorship based on the recommendations of the international committee of medical journal editors.

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Informed Consent: Informed consent was obtained from all participants in this study.

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