Nurses' Knowledge of Adverse Medication Events and its Contributing Factors at Intensive Care Units: A Cross-Sectional Study

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ABSTRACT

Context: Medication errors are a major concern in the healthcare setting, as they result from the inappropriate use of products related to the treatment or the effects that lead to harm. In Saudi Arabia, prescription errors constitute nearly one-fifth of all medication errors. Still, there is a difference in dealing with the process of using medications based on each country and its background.
Aim: To assess the ICU nurses' knowledge and contributing factors regarding adverse medication events at Makkah City Hospitals in Saudi Arabia.
Methods: The study was a cross-sectional study conducted among nurses at different hospitals in Makkah City, Saudi Arabia. A random probability sampling technique was used to choose the appropriate sample of nurses. The sample size was 155 nurses. A valid and reliable knowledge questionnaire on medication errors was used.
Results: There was good knowledge regarding adverse medication events for 13.5% of participants. Most participants (86.5%) had poor knowledge of adverse medication events. The mean knowledge score of ICU Nurses about Adverse Medication Events was 4.81±1.91 among males and 4.28±1,96 among females. There was no statistically significant relationship between nurses' knowledge about adverse medication events with gender (t-test 1.653, p-value=0.598), education level (r=-0.137, p-value=0.089), and workplace (r=0.072, p-value=0.376). There was a significant statistical negative relationship between ICU nurses' knowledge score about Adverse Medication Events with age (r=-0.251, p-value=0.002), nationality (r=-0.739, p-value=0.000), role/profession (r=-0.242, p-value=0.002). There was a significant statistical positive relationship between ICU nurses' knowledge score about Adverse Medication Events with work weekly hours (r=0.205, p=0.010)
Conclusion: The study's result underscores the importance of enhancing ICU nurses' knowledge and skills related to adverse medication events. Hospital management should provide training opportunities to help nurses develop their knowledge and skills in medication administration to prevent medication errors and ensure patient safety.

Keywords: Adverse-medication events, contributing factors, cross-sectional, knowledge, nurses, ICU

1. Introduction

Globally, in the healthcare setting, improving patient safety is a core component of quality of care that is a center of concern. Medication errors are widely reported as unintentional harm to patients. Medication errors refer to avoidable events that result from the inappropriate use of treatment products or the effects that lead to harm to the patient. It is important that the pharmaceutical treatments, when misapplied, are considered dangerous and life-threatening *(Alandajani et al., 2022).*

Escrivá Gracia et al. (2019) reported a worldwide frequency of medication errors of 1.93%. Errors in the timing of antibiotic administration (8.15% error rate), errors in high-risk medication dilution, concentration, and infusion rate (2.94% error rate), and errors in the administration of pharmaceuticals via nasogastric tubes (11.16% error rate) were the significant risk factors.

In general, in any step of the treatment, errors can occur, whether in prescriptions, or transcription, in addition to dispensing and administration, in any step in which doctors, pharmacists, and nurses are involved. Also, previous studies indicated that the most common step in medication errors is during the step of managing the medication process, representing eighty-seven percent of medical errors *(Fathi et al., 2017).*

In addition to the consequences of medication errors, intensive care units (ICU) are among the facilities that are particularly prone to errors because there are 1.7% medical errors per day for patients admitted to intensive care, making these situations potentially more dangerous. They are critically ill, with a 78% medication mistake rate higher than the average in other units, and the patients were critically unwell *(Escrivá Gracia et al., 2019). Escrivá Gracia et al. (2019)* concluded that nurses had a low degree of

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understanding about the medications they use most frequently and with which there are more medication errors in the ICU.

Another study conducted on medication errors in intensive care units concluded that expanding and deepening knowledge for nurses is considered one of the effective strategies with a high level of safety concerning medicines in intensive care units. According to the survey, ninety-three percent of nurses know that sufficient knowledge of calculating drug doses is necessary to reduce medication errors at the stage of drug preparation *(Di Muzio et al., 2017)*.

Providing and improving human health is nurses' primary professional objective. One of the most frequent health-threatening errors that have an impact on patient care is medication error. Such errors are a widespread issue that raises death rates, hospital stays, and associated expenditures *(Rodziewicz et al., 2023)*.

2. Significance of the study

In Saudi Arabia, prescription errors constitute nearly one-fifth of all medication errors. However, the percentage of errors that occur is different. Also, most medication errors are unintended, and the presence of safe health care leads to reducing the occurrence of medication errors. There is a difference in dealing with the process of using medications based on each country and its background *(Alshammari et al., 2021)*.

The first meta-analysis to ascertain the rate of medication errors in Saudi Arabia examined variety of reports and rates of medication errors (MEs) in Saudi Arabia. The search covered 16 articles. Hospitals in Saudi Arabia reported a 44.4% overall incidence of MEs. Out of the reported MEs, prescribing mistakes, dispensing errors, and administration errors events account for 40.2%, 28.2%, and 34.5%, respectively. However, it was also commonly discovered that between-study heterogeneity was >90%. (I-squared statistic). This study reveals how common MEs are in healthcare settings. More work in the field is required to upgrade drug management systems to reduce occurrences of patient injury *(Almalki et al., 2021)*.

Numerous studies have been conducted in Saudi Arabia on medication errors and nurses' knowledge. Studies have been conducted in Jeddah on nurses' knowledge of medication errors without clarifying the contributing factors associated with those errors. However, as far as we know, no study has been published in Makkah, specifically in intensive care units' nurses' knowledge. The study was designed to evaluate the knowledge of the ICU nurses on adverse drug occurrences at Makkah City hospitals in Saudi Arabia without focusing on pharmacokinetic mistakes and the factors related to their occurrence.

3. Aim of the study

This study assessed the ICU nurses' knowledge and contributing factors regarding adverse medication events at Makkah City Hospitals in Saudi Arabia.

4. Subjects & Methods

4.1. Research Design

The study was a cross-sectional study design carried out among nurses at different hospitals in Makkah City in Saudi Arabia. The benefit of a cross-sectional study is that it allows researchers to compare many different variables.

4.2. Study setting

The study was conducted at intensive care units at Makkah City Hospitals, including (Hera General Hospital, Alnoor Specialist Hospital, King Faisal Hospital, and King Abdul-Aziz Hospital) in Makkah, Saudi Arabia. The four governmental hospitals in Makkah, Saudi Arabia, are Hera General Hospital, Alnoor Specialist Hospital, King Faisal Hospital, and King Abdul-Aziz Hospital. Hera General is a 276-bed hospital that offers affordable services in various specialties. Alnoor Specialised Hospital is a 433-bed that provides high-quality care. King Faisal Center Hospital is a 210-bed that offers patients cutting-edge technology and international standard care. King Abdul-Aziz is a 248-bed hospital providing high-quality care and a relatively higher patient flow rate.

4.3. Subjects

A probability random sample of ICU Nurses working at Makkah City Hospitals in KSA was enrolled in this study. The required study sample was determined based on the inclusion and exclusion criteria from 257 nurses using the Open-Epi program at a confidence level of 95%, a margin of error of 5%, and a response distribution of 50%. Therefore, the sample size was 155 nurses from all intensive care units.
Inclusion criteria

The study included a registered nurse at the ICU who has completed at least one year in Makkah hospitals from both genders.
Exclusion Criteria

Nurses on special leave and training and nurses with experience of more than three years in Makkah hospitals were excluded.

4.4. Tools of data collection

4.4.1. Structured Interview Questionnaire

The researcher developed the study instrument based on the study of *Alandajani et al. (2022)*, which was provided in English. The questionnaire was divided into two parts:

The first part concerns demographic data such as age, gender, nationality, educational level, workplace, experience, role/profession as a nurse, weekly work hours, and attending training courses on medication adverse error reporting.

The second part consists of 9 questions to assess nurses' knowledge regarding medication errors, such as which one the nurse considers the most important when administering medication, which of the following does the nurse consider the least important when administering medication? and the most common preventable adverse events. Question number eight assesses the contributing factors to medication administration errors, such as interruptions during

medication rounds, lack of familiarity with the medications, lack of supervision for inexperienced staff, inadequate initial nurse training, poor quality control and management, high workload, lack of medication skills competence by the nurses, high patient-to-nurses ratio on wards/units, and high levels of patient need. Additionally, question number nine denotes the correct skills in medication administration, such as ethical consideration if medication error occurs, correct nurses' behaviors if medication errors occur, and documentation of medication errors.

Scoring system

Each correct response received one point; however, the wrong one received zero. The overall score was considered and categorized into good knowledge (scores ≥ 60) and poor knowledge (scores <60).

4.5. Procedures

Tools developed by the researchers after they reviewed related literature. Used tools were tested for content validity by a jury of three experts of nursing faculty staff, and any required modifications were done. The tool was tested for its reliability using alpha Cronbach's coefficient test, and the alpha reliability was 0.88.

Ethical approval was obtained from the Ethical Research Committee of Hail University (H-2023-037 Date 23/01/2023) and the general directorate of health affairs of Makkah City (H-02-K-076-0223-902 Date 26/03/2023). Furthermore, the purpose of the study was explained to the participants, and stressed that the information is confidential and that participation in the study is voluntary.

A random probability sampling technique was used to choose the appropriate sample of nurses. Nurses were selected probabilistically through the nurses' files arranged according to numbers. After obtaining the approval from the study participants, the questionnaire was distributed to the participants to fill out. As it was distributed on the link, it took about one month to collect data, which was then collected and analyzed.

4.6. Limitation of the study

Limitations of the study include the potential for response bias, as participants may have provided socially desirable responses or may not have accurately reported their experience. Additionally, the study only focused on ICU nurses in Makkah city hospitals, limiting the findings' generalizability to other regions or healthcare settings. The study also did not investigate the relationship between medication errors and patient outcomes, an important area for future research. Finally, the study did not explore potential interventions to address the identified contributing factors to medication errors.

4.7. Data Analysis

Statistical Package for Social Sciences (SPSS) version 26 for Microsoft Windows was used to analyze all the data (Chicago, IL, USA). Normality tests and descriptive statistics were applied to continuous variables to ascertain the data distribution. Then, regularly distributed variables were shown in means and standard deviations, whereas non-normally distributed variables and the interquartile range were summarized. Frequency and percentages were used to present categorical variables. Person correlation represents the variables' associations, and a p-value of ≤0.05 was used to determine significance.

5. Results

Table 1 shows the sociodemographic characteristics of the studied nurses. There were 155 nurses. Regarding the studied nurses' age, most of the participants were from the age of 30-40 years (43.2%). There were 76.1% Saudi and 23.9% non-Saudi, and 87.7% of participants had bachelor's degrees. 20%, 29.7%, 21.3%, and 29.0% worked at Hera General Hospital, Alnoor Specialist Hospital, King Faisal Hospital, and King Abdulaziz Hospital, respectively. Most of the participants were specialist nurses (70.3%). There, 67.1% had 1-2 years of experience, and 61.9% worked ≥ 40 hours weekly. There were 73.5% attended the training course on MER (Medication Adverse Error Reporting).

Figure 1 portrays that most of the participants were females, 60%.

Table 2 shows that 52.3% of participants answered incorrectly the question of the most important things to care for when administering medication, and 51.6% of participants answered incorrectly things considered to be the least important when administering medication.

In addition, the results show that 60.0% of participants answered incorrectly about the most common preventable adverse events. 71% of the nurses answered incorrectly regarding the causes of underreporting medication administration errors.

There were 52.3% of the participants answered incorrectly regarding the question related to the use of direct observation for medication administration accurate assessment. 63.9% answered incorrectly the correct elements in the medication administration accuracy assessment.

65.8% answered incorrectly question regarding the six safe practices observed in the medication administration accuracy assessment. All of the participants (100%) answered correctly the question related to the nurses' knowledge of contributing factors to medication errors.

There, 67.7% correctly answered the question regarding what the correct practices in medication administration are.

Figure 2 presents the percentage distribution of the total knowledge score of the studied nurses. The figure illustrates that 86.5% of the nurses had poor knowledge, while 13.5% had good knowledge.

Table 3 shows the mean for knowledge of male and female ICU Nurses about adverse medication events; males showed a mean score of 4.81±1.91, female 4.28±1.96. There is no significant statistical difference between male and female nurses at p-value=0.598.

Table 4 displays a non-statistically significant negative relationship between ICU nurses' knowledge and their educational level p-value=0.089.

Table 5 shows a non-statistically significant positive relationship between ICU nurses' knowledge and their workplace p-value=0.376.

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Table 6 highlights a statistically significant negative relationship between ICU nurses' knowledge and their age, p-value=0.002.

Table 7 portrays a statistically significant negative relationship between ICU nurses' knowledge and their nationality, p-value=0.000.

Table 8 displays a statistically significant negative relationship between ICU nurses' knowledge and their role/profession, p-value=0.002.

Table 9 explains a statistically significant positive relationship between ICU nurses' knowledge and their weekly work hours, p-value=0.010.

Table 10 demonstrates a non-statistically significant negative relationship between ICU nurses' knowledge and their work experience in years (p-value=0.530).

Table (1): Frequency and percentage distribution of the participants' sociodemographic characteristics (n=155).

Variables	No.	%
Age		
<30 years	65	41.9
30-40 years	67	43.2
More than 40 years	23	14.8
Mean ±SD	34.96±6.11	
Nationality		
Saudi	118	76.1
Non-Saudi	37	23.9
Education Level		
College Diploma	9	5.8
Bachelor's degree	136	87.7
Master's degree	10	6.5
Workplace		
Hera General Hospital	31	20.0
Alnoor Specialist Hospital	46	29.7
King Faisal Hospital	33	21.3
King Abdulaziz Hospital	45	29.0
Role/Profession		
General Nurse	39	25.2
Assistant Nurse	7	4.5
Specialist Nurse	109	70.3
Experience in years		
1-2	104	67.1
2-3	4	2.6
More than 3	47	30.3
Mean ±SD	3.63±1.72	
Work weekly hours.		
≥ 40 h	96	61.9
≤ 40 h	59	38.1
Attend training course on MER (Medication Adverse Error Reporting)		
Yes	114	73.5
No	41	26.5

6. Discussion

Adverse drug events (ADE), or injuries caused by drug therapy, are a frequent and serious problem in hospitalized patients. Monitoring, preventing, and treating ADEs is an important patient safety function. Nurses play a significant role in this function because their data is a unique and important indicator of ADEs and because they are the final point of medication administration *(Weir et al., 2022)*. Nurses are involved in direct patient care and are in a unique position to suspect, identify, and detect adverse drug reactions *(Scjott et al., 2022)*. The present study aims to assess the knowledge and contributing factors of adverse medication events among Makkah City Hospitals, KSA ICU nurses.

The highest percentage of participants in the study were females with a bachelor's degree and between 30-40 years of age. Specialist nurses constituted most participants; most had 1-2 years of experience and worked ≤40 hours weekly. The study also found that most participants attended training courses on MER, indicating younger qualified specialist female nurses trained in MER.

Regarding the nurses' knowledge of adverse medication events and their contributing factors, the study finds that most ICU nurses had inadequate knowledge about medication administration errors, as most participants answered incorrectly regarding the most important and least important factors to consider when administering medication. The findings indicate a lack of knowledge among ICU nurses regarding adverse medication events, which could lead to medication errors. These findings highlight the need for further education and training that emphasized on medication administration to enhance the knowledge and skills of ICU nurses. *Di Muzio et al. (2016)* study showed the same results regarding ICU nurses' knowledge
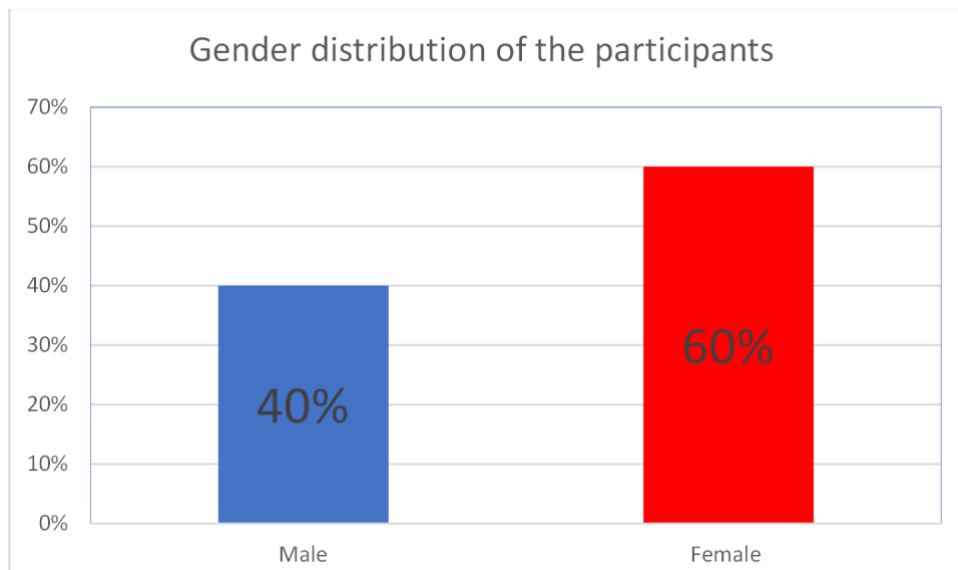
Figure (1): Percentage distribution of studied participants' gender.

Table (2): Frequency and distribution of the nurses' knowledge and contributing factors regarding adverse medication events (n=155).

| Items	Correct		Incorrect	
	No.	%	No.	%
Which one of the following do you consider to be the MOST important when administering medication?	74	47.7	81	52.3
Which one of the following do you consider to be the LEAST important when administering medication?	75	48.4	80	51.6
Causes of the most common preventable adverse events	62	40.0	93	60.0
The causes of most medication administration errors go unreported	45	29.0	110	71.0
The use of direct observation for medication administration accuracy assessment	74	47.7	81	52.3
The medication administration accuracy assessment includes	56	36.1	99	63.9
Which of the following is not one of the six safe practices observed in the medication administration accuracy assessment?	53	34.2	102	65.8
Based on your experience as a nurse, what are the contributing factors to medication errors?	155	100.0	0	0.0
Based on your experience as a nurse, which of the following practices is correct?	105	67.7	50	32.3
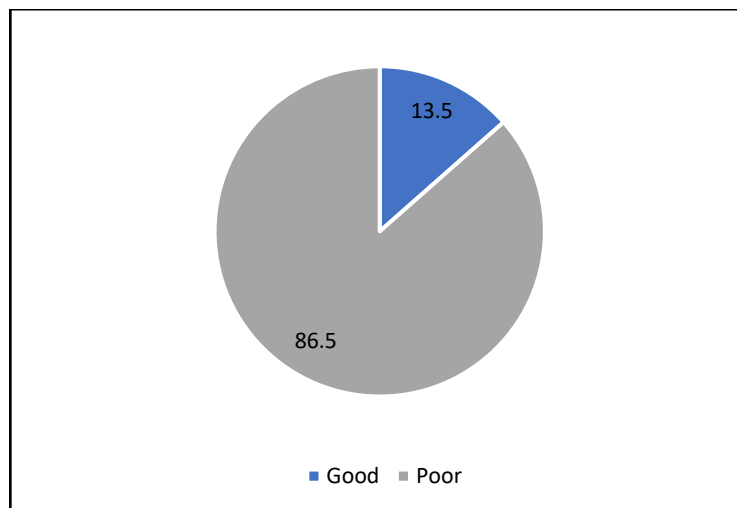
Figure (2): Percentage distribution of total knowledge score among the studied nurses (n=155).

Table (3): Effect of the participants' gender on knowledge among ICU nurses about adverse medication events (n=155).

Gender	Knowledge				
	N	Mean±SD	Std. Error Mean	t-test*	p-value
Male	62	4.81±1.91	0.24	1.653	0.598
Female	93	4.28±1.96	0.20		

Independent Samples Test

Table (4): Correlation between ICU nurses' knowledge about adverse medication events and their education level (n=155).

Variables		Knowledge	Education level
Knowledge	r*	1	-0.137
	P-value		0.089
Education level	r*	-0.137	1
	P-value	0.089	

r: Person correlation

Table (5): Correlation between ICU nurses' knowledge about adverse medication events and their workplace (n=155).

Variables		Knowledge	Work weekly hours
Knowledge	r*	1	0.072
	P-value		0.376
Workplace	r*	0.072	1
	P-value	0.376	

r: Person correlation

Table (6): Correlation between ICU nurses' knowledge about adverse medication events and their age (n=155).

Variables		Age	Score of knowledge
Age	r*	1	-0.251
	P-value		0.002
Score of knowledge	r*	-0.251	1
	P-value	0.002	

r: Person correlation

Table (7): Correlation between ICU nurses' knowledge about adverse medication events and their nationality (N=155)

Variables		Score of knowledge	Nationality
Score of knowledge	r*	1	-0.739
	P-value		0.000
Nationality	r*	-0.739	1
	P-value	0.000	

r: Person correlation

Table (8): Correlation between ICU nurses' knowledge about adverse medication events and their role/profession (n=155).

Variables		Score of knowledge	Role/Profession
Score of knowledge	r*	1	-0.242
	P-value		0.002
Role/Profession	r*	-0.242	1
	P-value	0.002	

r: Person correlation

Table (9): Correlation between ICU nurses' knowledge about adverse medication events and their weekly work hours (n=155).

Variables		Score Knowledge	Work weekly hours
Score of knowledge	r*	1	0.205
	P-value		0.010
Work weekly hours	r*	0.205	1
	P-value	0.010	

r: Person correlation

Table (10): Correlation between knowledge among ICU nurses about adverse medication events and work experience in years (n=155).

Variables		Score Knowledge	Experience in years
Score Knowledge	r*	1	-0.051
	p-value		0.530
Experience in years	r*	-0.051	1
	p-value	0.530	

*r: Person correlation

regarding preventing medication errors during the preparation and administration of IV drugs in the ICU; targeted teaching initiatives are required. Additionally, nearly all respondents indicated a significant level of interest in a particular training program *(Di Muzio et al., 2016)*.

Furthermore, all the study nurses identified several contributing factors to medication errors, including interruptions during medication rounds, lack of familiarity with medications, inadequate initial nurse training, poor quality control and management, high workload, and high patient-to-nurse ratio. These findings indicate that these factors play a role in medication administration errors and should be targeted by the hospital administration to be considered and corrected if they want to minimize the frequency of medication administration errors and increase the quality of care and patient safety. *Hammoudi et al. (2018)* study showed similar findings that medication packaging, nurse-physician communication, pharmacy procedures, nurse staffing, and transcription difficulties were the leading causes of nursing medication errors. The biggest obstacles to nurses reporting errors were differences in definitions, the administrative response, and fear of reporting.

The current study reveals, on one hand, an insignificant association between the nurses' knowledge mean score and nurses' gender. Also, a non-statistically significant relationship exists between ICU nurses' knowledge and their educational level, workplace, and years of experience. On the other hand, the study reveals a statistically significant negative relationship between ICU nurses' knowledge and their age, nationality, and role/profession. Additionally, a statistically significant positive relationship existed between ICU nurses' knowledge and their weekly work hours. These findings might be explained as the younger nurses had a higher knowledge as they have recently graduated and have a fresh knowledge regarding the medication. Also, foreign nurses might be more committed to the rules they are trained on. Besides, the specialist nurse could be more knowledgeable about medication administration errors. They constitute the higher percentage of the current study sample.

Similar correlations were reported by *Qedan et al. (2022)* in a study aimed to assess the nurses' knowledge and understanding of obstacles encountered when administering resuscitation medication. They reported a statistically significant relationship between the nurses' knowledge and gender, working unit, and position and a non-statistically significant association between their knowledge and age, marital status, hospital, residency, years of experience, educational level, and training.

A study conducted by *Alandajani et al. (2022)* to assess the knowledge and attitudes regarding medication errors

among nurses in a major Jeddah hospital reported that age, educational level, working place, role/profession, unit, years of experience, working weekly hours, and attendance of training, knowledge, and attitudes were statistically significant factors in medication administration errors, while, gender, nationality, marital status, monthly income were not statistically significantly associate with the medication administration error (MAE).

The study's results have important implications for nursing practice, highlighting the need for further education and training for ICU nurses regarding adverse medication events. Improving nurses' knowledge and skills in this area could help prevent medication errors and improve patient safety. The study's findings suggest that hospital management should address the factors contributing to medication errors identified in the study, such as high workload and inadequate initial nurse training, to improve patient outcomes.

7. Conclusion

The current study concludes that most participants have poor knowledge regarding adverse drug events, as the average knowledge of male nurses is higher than that of female nurses. Also, it could be concluded that nurses need to increase their knowledge level regarding adverse drug events to improve patients' safety, promote the quality of care, and raise awareness regarding drug events.

8. Recommendations

Based on the results of this study, the nursing implications of this study highlight the need for ICU nurses to receive regular and comprehensive training on medication adverse event reporting and prevention, to be more vigilant during medication administration, to address the contributing factors to medication errors, and to develop a culture of safety that promotes open communication and learning from medication errors.

Recommendations for further research

- A similar study can be conducted on a larger probability sample across different regions of Saudi Arabia to validate this study's findings and identify any regional variations.
- Future studies can explore the effectiveness of various educational interventions, such as simulation-based training, workshops, and seminars, in enhancing nurses' knowledge and skills regarding adverse medication events.
- Research can be conducted to identify the impact of the use of technology, such as barcode medication administration systems and electronic prescribing, on reducing medication errors in the ICU setting.

- A study can be conducted to investigate the relationship between nurse-patient ratios and medication errors in the ICU setting, as high workload and patient-to-nurse ratios were identified as contributing factors to medication errors in this study.
- Future research can also investigate the effect of incorporating medication safety into the ICU nurses' performance evaluation and quality improvement initiatives, as this can enhance the culture of safety in the workplace and improve patient outcomes.

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