

Effect of Medication Safety Guidelines on Prevention of Medication Errors among Nurses in the Intensive Care Unit

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Abstract

Background: Problems with medication are often referred to medication errors. Its effect on patient results in harm as it can vary widely. This depends on the particular knowledge and practices of nurses, as well as how the problem is picked up. Both serious and non-serious errors are often referred to as preventable incidents. So, medication errors that are commonly occurring among nurses in the intensive care units (ICU) can be prevented by improving nursing performance during the medication administration process. **Aim:** To assess the effect of medication safety guidelines on prevention of medication errors among nurses in the intensive care unit. **Setting:** This study was conducted at Kfr elsheikh University Hospital, in three main units Medical, surgical & Cardiac ICUs. **Sampling:** A convenient sample of 59 nurses working in the mentioned setting. **Tools:** Two tools were used for data collection. **First tool:** A self-administered questionnaire consisted of two parts. Part I concerned with nurses' demographic data. Part II concerned with nurses' knowledge assessment. **Second tool:** Nurses' practice observational checklist. **Results:** There was a highly significant difference between pre and post intervention using medication safety guidelines in relation to knowledge (p value= 0.000), practice (p value = 0.000) and medication errors (p value = 0.000) **Conclusion:** The application of medication safety guidelines had a statistically significant positive effect on the studied nurses' knowledge and practice and consequently decreased the frequency rate of all medication errors' types; which support the stated research hypothesis. **Recommendations:** The study recommended that; arranging continuous educational programs for nurses, construction of training endeavours based on the identified gaps to respond to unmet needs of nurses, and building a safety culture in health care setting.

Key words: Medication Safety Guidelines, Medication Errors, Nurses& Intensive Care Unit.

Introduction

Medication errors are a significant worldwide concern and cause serious medical consequences for patients (World Health Organization [WHO], 2017). Despite the increased awareness about patient safety and quality of care, medication errors and adverse patient outcomes occur frequently in clinical practice. Researchers are estimating the medication errors' rate in dose by 19.6% in the United States, a country with the most sophisticated healthcare delivery system in the world (*Tariq et al., 2020*).

Medication errors cause at least one death every day and injury to approximately 1.3 million people annually in the United States of America alone. While low- and middle-income countries are estimated to have similar rates of

medication-related adverse events to high-income countries, the impact is about twice as much in terms of the number of years of healthy life lost. Many countries lack good data, which should be gathered as part of the initiative. Globally, the cost associated with medication errors has been estimated at US\$ 42 billion annually or almost 1% of total global health expenditure. Errors may also be classified according to their level of severity (*WHO, 2017*).

Unsafe medication practice and medication errors are a leading cause of injury and avoidable harm in health care systems across the world. Globally, the cost associated with medication errors has been estimated at \$42 billion USD annually. Errors can occur at different stages of the medication use process.

Medication errors occur when weak medication systems and/or human factors such as fatigue, poor environmental conditions or staff shortages affect prescribing, transcribing, dispensing, administration and monitoring practices, which can then result in severe harm, disability and even death. Multiple interventions to address the frequency and impact of medication errors have already been developed, yet their implementation is varied. A wide mobilization of stakeholders supporting sustained actions is required. In response to this, WHO has identified Medication without Harm as the theme for the third Global Patient Safety Challenge (*Garfield, Chan, Vujanovic et al., 2020*).

Critical care nurses work with a multitude of potent and lifesaving medications that paradoxically can pose a considerable risk for injury and harm when some errors that are common in critical care units occur. Besides the pharmacokinetics being responsible for injury and harm, other sources of harm resulting from medication errors include the level of nurse experience, shift worked or time of day, lack of computerized orders, and distractions and interruptions (*Adam & Howard, 2017*).

Significance of the study

Some medications may have narrow margin of safety between therapeutic and harmful doses, which may produce serious side effects, and require close monitoring to determine their effectiveness in individual patients (*Juan, Jean-Yves & Phillipe, 2015*).

Regarding Egyptian statistics; it was found that, prescribing errors were the most common type of Medication Errors (MEs) (54%) followed by monitoring (25%) and administration errors (16%). The most frequent error was incorrect dose (20%) followed by drug interactions, incorrect drug, and incorrect frequency. Most reports were potential (25%), prevented (11%), or harmless (51%) errors; only 13% of reported errors lead to patient harm (*El-Shazly, Al-Azzouny, Soliman, Abed & Attia, 2017*).

The researcher observed over a period of time during working in critical care units that; some errors occur frequently during drug

prescription, transcription, preparation and administration. Therefore, the developed guidelines for the studied nurses to address the various components of safe and effective medication administration in practice setting was very important for preventing/ decreasing MEs among the nurses working in ICUs.

Aim of the study

The aim of this study was to assess the effect of medication safety guidelines on prevention/decreasing the medication errors frequency rate among the nurses in the intensive care unit.

Through the following:

1. Assessing the nurses' level of knowledge regarding medication safety overview and medication safety guidelines' components
2. Assessing the nurses' level of practice pre application of the training program regarding medication safety guidelines' components.
3. Assessing types and frequency rate of medication errors in the ICU; pre application of medication safety guidelines' components.
4. Applying the training program regarding medication safety guidelines' components for the nurses based on their needs assessment.
5. Evaluating the nurses' level of knowledge post application of the training program regarding medication safety guidelines' components.
6. Evaluating the nurses' level of practice post application of the training program regarding medication safety guidelines' components.
7. Evaluating types and frequency rate of medication errors in the ICU; post application of the training program regarding medication safety guidelines' components.

Research hypothesis:

To fulfill the aim of the study the following hypothesis was formulated:

H: The medication safety guidelines application will have a significant positive effect on prevention/ decreasing the medication

errors frequency rate among the nurses in the Intensive Care Unit.

Subjects & Methods

Technical design

The technical design included research design, setting, subjects and tools of data collection used in this study.

Research Design:

A quasi experimental design was used.

Setting:

This study was conducted at the intensive care units (ICU) at Kafr elsheikh University Hospital in Kafr elsheikh Governorate. This hospital serves all sectors of people in Kafr elsheikh governorate. The hospital contains three main ICUs; Medical (MICU), Surgical (SICU) & Cardiac Care Unit (CCU).

Subjects:

A convenient sample included all available nurses at the time of the study (n=59), working in the previously mentioned setting and accepted to participate in the study, from both gender, with bachelor degree qualification, different age groups, and years of experiences were recruited to this study. They distributed as follow: Cardiac Care Unit (CCU): 21 nurses, Surgical ICU: 14 nurses and Medical ICU: 24 nurses. The studied sample included 3 head nurses, 9 charge nurses and 47 staff nurses.

Tools of Data Collection

1- Self-administered questionnaire; consisted of two parts (A&B)

A. Demographic data; It was concerned with the demographic data (age, gender, educational qualifications, job title, unit of specialty and years of experience).

B. Nurses' knowledge assessment: It was developed by the researcher after reviewing the recent literature review, *Mullner & Chung, (2002), the American Hospital Association, (2002), Institute of Medication Practice, (2002), & Zayed (2012)*. It was used to assess the nurses' level of knowledge regarding medication safety guidelines' pre and post its application.

Part a: Concerning medication safety overview, which included (5 items) about patient safety, medication safety, medication errors, medication errors' types and medication errors' reasons.

Part b: True false questions concerning medication safety guidelines which included 10 components distributed as the following; drug labeling, packaging, and nomenclature (8 items), drug storage, stock and standardization (8 items), environmental factors (7 items), patient information (8 items), drug information (7 items), communication of drug information (11 items), staff competency and education (10 items), patient education (6 items), quality process and risk management (9 items) & drug device acquisition, usage and monitoring (10 items). So the total items of the guidelines components were 84 items. The total items of the nurses' knowledge assessment sheet 89.

❖ Scoring System:

The responses to each item were either (correct or incorrect). Weighted scores were assigned to the response choices as the following; the correct answer took score (one) and incorrect answer took (zero). So, the total score of the total items was 84 and the cutoff point of the tool was 90% of the total score distributed as the following.

- < 90% (< 80.1 from the total score 89) ----> considered unsatisfactory level of knowledge.
- ≥ 90% (≥ 80.1 from the total score 89). ----> considered satisfactory level of knowledge.

2- Nurses practice observational checklist: This tool was developed by the researcher after reviewing the related literature *WHO (2017), Adrienne (2014) & Cheragi et al., (2013)*. It was designed to assess the nurses' practice; regarding medication safety guidelines' 10 components and estimate the frequency of medication errors types which included (13) types, pre and post guidelines' application.

❖ Scoring system:

Each component item was scored as follow; done correctly or safely took score (1) and done incorrectly or unsafely or not done took score (zero) and consequently, the

medication errors types were estimated as the following; prescribing error (24 items), monitoring error (20 items), drug preparation error (22 items), deteriorated error (13 items), fragmented error (10 items), technique error (11 items), dose error (9 items), adherence error (7 items), unauthorized error (3 items), compliance error (5 items), omission error (3 items), wrong time error (1 item), and dose form error (2 items). The total grade of the checklist was 130, and the cutoff point of the tool was 90% of the total score distributed as the following.

- < 90% (< 116.1 from the total score 129) ---
→ considered unsatisfactory level of practice
- ≥ 90% (≥ 116.1 from the total score 129) ---
→ considered satisfactory level of practice.

Operational design:

It included preparatory phase, tools validity and reliability, pilot study and field work.

A. The preparatory Phase:

This phase was carried out through the following steps:

- 1- Reviewing of related literature, and theoretical knowledge of various aspects of the study using books, articles, internet, periodicals and magazines to develop data collection tools.
- 2- Outlining all components of medication safety guidelines through extensive review of the literature and other available resources.
- 3- Obtaining experts' opinion to ensure contents validity of the developed tools & training program content.

Validity and Reliability

Testing validity of the proposed tools by inspecting the items to determine whether the tools measure what supposed to measure, *Studebaker et al., (2002)*. This stage developed by a jury of 7 experts from different academic categories (2 professors and 5 assistant professors) of the medical –surgical nursing at the faculty of nursing, Ain Shams University. The expertise reviewed the tools for clarity, relevance, comprehensiveness, simplicity and minor modification was done.

Testing reliability of the proposed tools was done statistically by Cronbach alpha test. Reliability defined as the overall consistency of a measure. A measure said to have a high reliability if it produces similar results under consistent conditions (*Sharma, 2014*). Cronbach alpha test for demographic data was 0.802., for knowledge assessment sheet was 0.864., for nurses practice observational checklist was 0.879., and for the total tool was 0.868.

Pilot Study:

A pilot study was carried out on 10% of the studied sample (6 ICU nurses) at Kafr elsheikh University hospital to assess the clarity of the tools' language, applicability of tools, and the time needed for filling data collection tools. The subjects who included in the pilot study were excluded from the main study group.

Ethical Considerations:

The ethical research considerations in this study included the following:

- The research approval was obtained from the Faculty of Nursing Ain Shams University Ethical Committee before starting the study.
- The researcher clarified the objectives and aim of the study to nurses included in the study before starting.
- The researcher assured maintaining anonymity and confidentiality of subjects' data included in the study.
- Nurses were informed that they were allowed to choose to participate or not in the study and they had the right to withdraw from the study at any time.

Field Work:

It was conducted in three phases; assessment and planning phase took 4 months, implementation phase took 6 months and evaluation phase took 4 months. The study started from June 2018 to August 2019.

I. Assessment and planning phase:

The researcher met the ICU nurses at Kafr elsheikh University Hospital. The researcher obtained their consent for participating in this study after explaining its aim. The researcher visited the selected setting two days / week Monday and Wednesday. Each

nurse was observed by the researcher through the whole process of medication management for assessing medication safety guidelines components were applied.

The researcher observed about 2 or 3 nurses in the day of each visit, by continuous observation for an average time 30 minutes for each one until covered all the nurses in the unit then followed the same manner in the other selected units to complete the study subjects.

The questionnaire was distributed to the studied nurses after explaining the purpose of the study. The participants were asked to give comments on the questionnaire items in term of clarity and completeness. Filling in the self-administered questionnaire, including the demographic data and knowledge assessment sheet, was done by the nurses pre the medication safety guidelines' components application. Each nurse took about 20 to 30 minutes to complete the sheet.

All information collected through the study tools were interpreted accurately for identifying individualized teaching needs to be a base for giving the training program contents accordingly.

• **The overall goal of the program:**

The training program aimed to prevent / decrease the medication errors' frequency rate by increasing the level of knowledge and practice of the nurses within the ICUs. The researcher set up teaching plan covering all the following aspects; equipping, acquiring knowledge, demonstrating practice, and allocating the resources and facilities for applying medication safety guidelines (printed material, power point presentation, posters, videos) and location of sessions that best served the learners. The appointment for starting teaching sessions was determined and scheduled with the staff and managerial staff as two days weekly.

• **Program Development:**

The program was designed by the researcher based on the baseline results obtained from the study tools. Also, recent, current, national and international related

literature was reviewed. The program content was revised and validated by 7 experts in Faculty of Nursing, Medical Surgical Nursing Department, Ain Shams University.

II. Implementation phase:

The teaching sessions were conducted in a classroom in each unit. The classroom was quite, had adequate lighting, well ventilated, and had adequate spacing for the place for implementing the target guidelines. Duration of each session took 30 minutes to 45 minutes / day.

These sessions were conducted for small groups; each group number ranged between 6 to 7 nurses. So, the session was repeated in the days of visit for each unit to cover the nurses in all groups and according to the assignment of each ICU, to be sure that all the nurses in each unit took the same lectures and content according to the stated schedule of the training program.

At the beginning of each session, an orientation on the importance of medication safety guidelines was explained to nurses to motivate them following these guidelines' components.

Each session started by greeting the nurses, assessing their motivation for learning, presenting the objectives, showing, and explaining the topic by using simple language to suit the understanding level of all subjects.

Getting feedback about what was explained and given through the session and facilitating for asking any questions about the topic.

The researcher emphasized on the importance of adherence to each step in medication safety guidelines for reducing patient stay, improving practice level, and improving the reputation of the setting through reducing the frequency rate of all types of medication errors. The researcher encouraged the nurses to express their readiness for changing behavior.

Implementation of medication safety guidelines' training program for the nurses in the three units lasted over a period of 6 months divided into 1 preliminary session, 4 sessions

for theory 9 sessions for application and 1 session for revision and evaluation of the program, at the morning and afternoon shifts.

• **Teaching methods:** Lectures, group discussion, demonstration and re-demonstration, and teaching on spot. The media used were designed especially for covering all the program content sessions such as; power point presentations, posters, videos, and guiding booklet based on the needs assessment.

III. Evaluation phase:

The evaluation phase done immediately after medication safety guidelines components' application and emphasized on determining the effect of medication safety guidelines' components on the nurses' level of knowledge and practice and estimation the frequency rate of medication errors types, through filling in the used study tools. The researcher distributed the knowledge assessment sheet on the studied nurses' for measuring their knowledge.

Each studied nurse was observed throughout the process of medication management using the nurses' observational checklist. The observation was conducted at different time period at the days of researcher visit.

The program outcome was evaluated immediate post program implementation of the medication safety guidelines using the same tools and approaches used in the preprogram assessment. Also, the collected data pre and post application of the training program were compared regarding the guidelines' implementation

IV. Statistical Design:

All data were collected, tabulated and subjected to statistical analysis. Statistical analysis is performed by SPSS in general (version 20), also Microsoft Office Excel is used for data handling and graphical presentation. Quantitative variables are described by the Mean, Standard Deviation

(SD), while qualitative categorical variables are described by proportions and percentages. Chi-squared test of independence is used for categorical variables. A statistically significant difference was considered at p-value $p \leq 0.05$, and a highly statistically significant difference was considered at p-value $p \leq 0.001$.

Result:

Table (1): Showed that, 52.54% of the nurses were in the age category (25 < 30 years), regarding gender 79.66% of them were females & 100% of them had a bachelor degree. In relation to the ICU type 40.68% of the nurses were in medical ICU, (79.66%, 15.25%, and 5.08%) of them were staff nurses, charge nurses and head nurses respectively. Regarding nurse patient ratio; it was found that 100% of them were assigned to only 2 patients).

Table (2): Showed that the nurses had got a satisfactory level of knowledge $\geq 90\%$ regarding 5 components post medication safety guidelines' components application.

Table (3): Showed that the nurses had got a satisfactory level of practice $\geq 90\%$ regarding 5 components post medication safety guidelines' components application.

Table (4): Showed that total frequency rate of all types of medication errors' was decreased post application of medication safety guidelines' components (0.9%) than (4.46%) with a highly significant difference at ($P \leq 0.001$).

Table (5): Showed that there was a significant positive correlation between the studied nurses' total knowledge and total practice post guidelines application ($r=0.702$). Also, there was a significant negative correlation between total practice and total frequency rate of medication errors ($r=-0.685$) post guidelines application at ($P \leq 0.001$).

Table (1): Frequency and percentage distribution of the studied nurses according to their demographic characteristics (n=59).

Items	No	%	
Age	20 < 25 years	13	22.03%
	25 < 30 years	31	52.54%
	30 – 35 years	15	25.42%
Gender	Male	12	20.34%
	Female	47	79.66%
Level of education	Bachelor degree	59	100%
	CCU	21	35.59%
Unit	Surgical ICU	14	23.73%
	Medical ICU	24	40.68%
Job description	Nurse	47	79.66%
	Charge nurse	9	15.25%
	Head nurse	3	5.08%
Years of experience	1 < 5	32	54.24%
	5 < 10	12	20.34%
	10 – 15	15	25.42%
Staff nurses/patient ratio	1:2	56	100%

Table (2): Frequency and percentage distribution of the satisfactory level of the studied nurses' knowledge pre and post medication safety guidelines' components application (n=59).

Items	Pre		Post		Z	P value
	No	%	No	%		
Medication safety overview	17	28.81%	59	100%	8.08	0.000**
Medication safety guidelines' components						
Drug labeling, packaging and nomenclature	11	18.64%	39	66.10%	5.22	0.000**
Drug storage, stock and standardization	18	30.51%	55	93.22%	4.05	0.000**
Environmental Factors	19	32.20%	39	66.10%	3.68	0.000**
Patient information	8	13.56%	22	37.29%	2.96	0.003
Drug information	0	0.00%	15	25.42%	4.15	0.000**
Communication of Drug Information	29	49.15%	54	91.52%	4.56	0.000**
Competency and staff education	28	47.46%	54	91.52%	7.45	0.000**
Patient education	25	42.37%	42	71.19%	3.16	0.001**
Quality Process and Risk Management	11	18.64%	32	54.24%	4.02	0.000**
Drug device acquisition, use and monitoring	31	52.54%	55	93.22%	8.07	0.000**
Total knowledge score	4	6.78%	53	89.83%	7.17	0.000**

Satisfactory level ≥ 90 means safe knowledge**Table (3):** Frequency and percentage distribution of the satisfactory level of the studied staff nurses' practice pre and post medication safety guidelines' components application (n=47).

Items	Pre		Post		Z	P value
	No	%	No	%		
Drug labeling, packaging and nomenclature	7	14.89%	47	100%	8.34	0.000**
Drug storage, stock and standardization	0	0.00%	47	100%	9.70	0.000**
Environmental factors	0	0.00%	1	2.13%	1.01	0.314
Patient information	0	0.00%	47	100%	9.70	0.000**
Drug information	2	4.26%	43	91.49%	8.47	0.000**
Communication of drug information	0	0.00%	47	100%	9.70	0.000**
Competency and staff education	0	0.00%	26	55.32%	6.00	0.000**
Patient education	0	0.00%	0	0.00%	Equal Values	
Drug device acquisition, use and monitoring	2	4.26%	31	65.96%	6.27	0.000**
Total practice score	0	0.00%	16	34.04%	4.39	0.000**

Satisfactory level ≥ 90 means safe practice

Table (4): Frequency and percentage distribution of the medication error type's frequency rate pre and post medication safety guidelines' components application.

Types of Medication Errors	Pre		Post		Z	P Value
	No	%	No	%		
Prescribing error	730	13.39%	66	1.21%	24.44	0.000**
Monitoring error	243	4.46%	63	1.16%	10.44	0.000**
Drug preparation error	215	3.94%	73	1.34%	8.48	0.000**
Deteriorated error	378	6.93%	46	0.84%	16.45	0.000**
Fragmented error	4	0.07%	0	0.00%	2.00	0.045
Technique error	376	6.90%	26	0.48%	17.79	0.000**
Dose error	276	5.06%	62	1.14%	11.82	0.000**
Adherence error	417	7.65%	254	4.66%	6.50	0.000**
Unauthorized prescribing error	108	1.98%	8	0.15%	9.33	0.000**
Compliance error	169	3.10%	0	0.00%	13.10	0.000**
Omission error	77	1.41%	21	0.39%	5.68	0.000**
Time error	82	1.50%	21	0.39%	6.04	0.000**
Dose form error	84	1.54%	0	0.00%	9.20	0.000**
Total	3159	4.46%	49	0.9%		0.000**

**P≤ 0.001 highly significant

Table (5): Correlation between nurses' level of knowledge and practice scores post medication safety guidelines' components application.

Items	Total knowledge	Total practice	Total errors
Total knowledge	r.	0.702	-0.568
	p	0.002*	0.009
Total practice	r.	0.702	-0.685
	p	0.002*	0.005*
Total errors	r.	-0.568	-0.685
	p	0.009	0.005*

Discussion

Medications are of a great benefit to patient's lives for relieving pain or curing illness. Medications may be very dangerous if improperly used, moreover medication safety is one of the highest priorities of nursing practice, a matter of considerable concern for all health team members. Medication errors produce a variety of problems for patients ranging from minor discomfort to substantial morbidity that may prolong hospitalization or lead to death and risk of litigation (*WHO global patient safety challenge, 2017*).

The findings of current study results revealed that the age of more than half of the ICU nurses was ranged between twenty five to less than thirty years (**table 1**). From the researcher point of view; this was a good chance for the success of the study program, through changing those nurses' performance (knowledge and practice) to the better though;

assessing their actual educational needs related to the medication safety and working on it. Because this age group included the newly hired staff nurses who were full of energy and enthusiasm.

Concerning gender; the findings of the current study results showed that; more than two thirds of the studied nurses were females (**table 1**). This study result was consistent with *Bellani et al., (2016)* who concluded in the study entitled "Epidemiology, patterns of care, and mortality for patients with acute respiratory distress syndrome in ICUs in 50 countries" that majority of the studied nurses group was females in the middle age. From the researcher point of view; this may return to the fact that most of the nurses are females everywhere.

As regards the educational qualifications; the findings of the current study results showed that the entire sample had a bachelor degree in nursing (**table 1**), from the researcher point of

view this may be due to the hospital nursing and medical managers preferred to maximize the benefit to patient care into the hot areas as ICUs. Also, the study results revealed that; more than half of the study subjects had years of experience ranged from one to less than five years. The current study result was agreed with, studies done by *Mayo & Duncan, (2004)* and the *Osborne, Blias & Hayes, (1999)* in their study “Nurses’ perceptions: when is it a medication error?” as they showed that, no relationships were found between medication practices or perceived sources of errors by years of experience.

On the other hand, this result was not agreed with *Blegen, Vaughn, and Goode, (2013)* who mentioned that many research studies are generally considering that more experienced and highly educated nurses are more oriented and provide higher quality of care. As well, *Coomber & Barriball (2007)*: conducted a study entitled; “Impact of job satisfaction components on intent to leave and turnover for hospital-based nurses: a review of the research literature” in which they identified that a wide range of factors have been put forward as influencing the performance and perception of nurses as level of education.

Regarding nurse patient ratio; the study results revealed that; all the ICU nurses were responsible to give care for only two patients. From the researcher’s point of view this may return to the need to achieve a proper nursing care for the acutely ill patients. However, at the time of high severity cases, the assignment was changed by the head nurse to become one to one, as it was observed by the researcher and also stated by the nurses themselves. This result was congruent with *Sakr & Yasser et al. (2015)* in the study entitled “The Impact of Hospital and ICU Organizational Factors on Outcome in Critically Ill Patients” they mentioned that, the ideal nurse patient ratio in the acutely ill areas, always be one to one or maximum can be one nurse to two patients.

In relation to the satisfactory level of knowledge regarding all components of medication safety guidelines (**table 2**), the

current study results revealed that; the majority of the studied nurses had got a highly statistical significant improvement in knowledge regarding medication administration process post application of medication safety guidelines. This study results was congruent with *Jennifer, Helene & Ginger, (2020)* in the qualitative systematic review entitled “Nurses’ Perceived Causes of Medication Administration Errors” in which concluded that; Causes of medication administration errors were perceived by nurses to be multifactorial and interconnected, and often stem from training defects and systems issues. Multifactorial interventions as nurses’ training programs aimed at mitigating medication errors required with an emphasis on systems changes. Findings in this review can be used to guide efforts aimed at identifying and modifying factors contributing to medication administration errors.

This study result was also supported by *Abukhader, (2020)*. In the study entitled; “Effect of medication safety education program on intensive care nurses’ knowledge regarding medication errors” who concluded that; educational program on medication safety improved the knowledge of critical care nurses regarding intravenous medication errors. This study recommended that medication errors should be periodically assessed by improving clinical guidelines of medication administration.

In relation to the satisfactory level of practice regarding all components of medication safety guidelines (**table 3**), the current study results revealed that; the majority of the studied nurses had got a highly statistical significant improvement in their practice regarding medication administration process post application of the medication safety guidelines. This study results was congruent with *Mekonnen & Alemayehu, (2018)*, in the systematic review entitled “Medication Reconciliation as a Medication Safety Initiative” which had shown that medication reconciliation interventions carried out at hospital transitions were found to be an effective strategy for improving clinical experience resulting in improving outcomes (e.g. adverse drug event, all-cause readmissions, and

emergency department visits), as well as process outcomes, such as the occurrence of medication errors.

Regarding medication errors' frequency rate, the current study results showed that; there was a highly statistical significant decrease post medication safety guidelines' component application than pre (**table 4**). This study result was supported by *Elizabeth, Roughead & Susan, (2009)* in the study entitled "Medication safety in acute care in Australia: where are we now? Part 1: a review of the extent and causes of medication problems 2002–2008". In which the author concluded that drug errors had reduced to 1.3% in admissions, and were associated with an adverse drug reaction at the time of the admission and required treatment.

In the same line the study finding was also supported by *Andrea et al., (2010)* in the study entitled; "Adverse Drug Events: Lessons from a Break through Series Collaborative" in which they pointed out that; eight types of medication errors had changes, with a success rate of 70%. This was based on changes included non-punitive reporting, ensuring documentation of allergy information, standardizing medication administration times, and implementing preprinted policies.

On the other hand, the study result revealed that; the most frequent type of medication errors pre medication safety guidelines' component application was the prescribing error, this result was not agreed with *Bates, Boyle, Vander Vliet, Schneider & Leape, (1995)* in the study entitled "Relationship between Medication Errors and Adverse Drug Events" who found that the most frequent type of errors was the omission dose error, followed by the wrong dose error.

Meanwhile, this study result was consistent with *Gandhi et al. (2005)* in the study entitled "Outpatient prescribing errors and the impact of computerized prescribing" in which they concluded that; prescribing errors was an obvious problem as it occurred in 7.6% of prescriptions and many could have harmed

patients. From the researcher's point of view, this finding may be related to the fact that there is many factors can determine the prescribing error, from those some factors related to the physician as the false or improper diagnosis, some related to patients and their complain which may be vague, and also factors related to misleading diagnostics as false lab results.

The study results revealed that; there was a highly significant positive correlation between total knowledge and total practice post guidelines application (**table 5**). This study result was agreed with *Shahin, (2012)* in the study about "Impact of a Designed Instructional Program about Enteral Nutrition on the Nurses' Knowledge and Practice at the Critical Care Department of Al-Manial University Hospital" as they found that; nurses' practices directly influenced by their knowledge and knowledge were essential to achieve best practices.

While, this study result was disagreed with *El-Sayed, Gomaa, & Abdel-Aziz, (2015)* in the study entitled "Nurses' Knowledge and Practice for Prevention of Infection in Burn Unit at a University Hospital: Suggested Nursing Guidelines" who found that; no significant relation was found regarding total nurses' knowledge and their total practice.

This study result was not supported by *Abdullah (2014)* in the study entitled "Nurses' Knowledge and Practices about Administration of Medications via Nasogastric Tube among Critically Ill Patients" as found there was a negative relation with a highly significant statistical difference between nurses' pre-intervention knowledge and practice scores.

Also, there was a highly significant negative correlation between total knowledge, total practice and total medication errors in pre and post guidelines application, this clarify the importance of improving the nurses' knowledge and its effect on the improvement of practice. In addition, it underlined the successful effect of the training program as it decreased the frequency rate of the medication errors, which strongly supported the hypothesis of the current

study.

Conclusion

Based on findings of the present study, it can be concluded that:

The application of the medication safety guidelines had a highly statistically significant positive effect on the studied nurses' knowledge and practice, and consequently decreased the frequency rate of medication errors among nurses in ICU; which support the stated research hypothesis.

Based on the results of the current study, the following suggestions for future research and practice are proposed:

1. Continuous in-service training programs for all ICU nurses at different hospitals regarding the suggested medication safety guidelines for decreasing the frequency rate of medication errors.
2. Arabic booklet about medication safety guidelines should be available for all ICU nurses at all settings.
3. Further researches are recommended to study the impact of the program regarding medication safety guidelines & medication errors on nurses' performance on the long run.
4. Further researches are recommended to study the factors affecting nurses' compliance regarding following medication safety guidelines components.
5. Using the study findings as a basis for construction of training endeavors based on identified knowledge and practice gaps to respond to their unmet needs.
6. Building a safety culture in the health care setting which provides a comforting environment for the ICU staff nurses regarding the improvement of reporting medication errors.
7. Further researches are needed to study the impact of medication safety guidelines & medication errors frequency rate on patient progress and length of stay.
8. Collaboration between pharmacists and nurses is paramount to improve the quality

of drug supply chain and decrease the risk of medication errors.

9. Publishing posters containing medication safety guidelines in all ICUs in different health care setting.
10. Periodical assessment of the ICU nurses knowledge and practice to detect the areas to be covered in training education courses to improve their practice regarding medication management and medication errors.
11. Replication of the research study on a large probability sample is recommended to achieve more generalization.

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