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# Effectiveness of Nursing Guidelines on Nurses' Performance Regarding High Alert Medications at Neonatal Intensive Care Units

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**ABSTRACT**

***Context:*** A high alert medication (HAM) is a medication that causes serious harm if it is used in error. Neonatal nurses are responsible for administering HAMs; incorrect administration can significantly affect clinical outcomes.

***Aim:*** The study aimed to evaluate the effectiveness of nursing guidelines on nurses' performance regarding HAMs at neonatal intensive care units (NICUs).

***Methods****:* A quasi-experimental design (pre/post-test) was utilized. The study was conducted at NICUs in Children's Hospital and Maternity and Gynecological Hospital affiliated to Ain Shams University. A convenience sample of 80 nurses caring for high-risk neonates was included in the current study from the previous setting for six months. Two tools were used to collect data. They are a structured interview questionnaire and nurses' performance observational checklist.

***Results:*** The nurses mean age was 27.79±6.83. 35% of them were worked as part time job. A highly statistically significant improvement was shown post-test compared to the pre-test regarding the nurses' knowledge and practices about HAMs at 0.001.

***Conclusion*****:** The present study concludes that applying nursing guidelines interventions improved the neonatal nurses' knowledge and practice related to HAMs. The study recommended emphasizing the importance of using nursing guidelines of HAMs interventions for improving neonatal nurses' knowledge and practices at NICUs

***Keywords:*** Nursing guidelines, high alert medication, nurses' performance

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## 1. Introduction

A high alert medication (HAM) is a medication that carries a heightened risk of causing significant harm if it is used in error. Medications classified as HAMs have a narrow therapeutic index. Medication with a narrow therapeutic index is risky because small changes in dose or drug blood levels can lead to dose- or blood concentration-dependent critical events *(Yin et al., 2016).* With HAMs, adverse events are persistent, life-threatening, permanent, and can lead to disability or death *(Alghamdi et al., 2019).*

Although determining the prevalence of medication errors in the NICU is challenging, published research show that medication errors are widespread in the NICU, with rates ranging from 13 to 91 per 100 NICU admissions. In addition, Neonatal Intensive Care Unit (NICU) patients are more likely than other hospitalized patients to face pharmaceutical errors, and they are more likely to suffer harm because of such errors. *(Eslami et al., 2019).*

Medication errors are as high as 57 percent in treating preterm newborns (24 to 27 weeks gestational age), compared to only 3 percent in the care of full-term infants. Medication errors are eight times more frequent in newborns than in adults. These data demonstrate that neonates in NICU require a precise system to protect against medication errors. Neonatal ICU healthcare providers must be extremely vigilant when working with these types of medications *(Leopoldino et al., 2019).*

Classes/categories of high alert medication as adrenergic antagonists, IV (e.g., propranolol, labetalol), anti-arrhythmic IV (e.g., lignocaine (lidocaine), amiodarone), antithrombotic agents (e.g., heparin), inotropic medications, IV (e.g., digoxin, dobutamine, dopamine), parenteral and oral dextrose, hypertonic, 20% or IV magnesium sulphate injections, moderate sedation agents, IV opiates and narcotics. Parenteral nutrition preparations, potassium salt injections, sodium chloride solution (greater than 0.9%), and adrenergic agonists, IV (e.g., adrenaline) *(De Basagoiti et al., 2021).*

The vulnerable status of neonates in the NICU, the complexity of the drugs regimen employed, and the challenging NICU environment combine to make the pharmaceutical administration process in the NICU unique and inherently risky. Drug-sensitive organs such as the renal, gastrointestinal, and hepatic systems are maturing in neonates in the NICU, resulting in varying responses to medications and illness. Weight-based medications are universal, necessitating calculations for each dose

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*(Hockenberry & Wilson, 2019).* However, some medications are also based on gestational age, making it even more complex. Long hospital stays are common for neonates in the NICU, which increases their exposure to drugs and medication errors. The immaturity of developing bodily systems impacts drug absorption, distribution, metabolism, and excretion in premature newborns, posing an exponential risk of medication errors *(Greenberg et al., 2018).*

The Neonatal Intensive Care Unit is a highly complex, stressful, technology-driven environment which provides multidisciplinary care to critically ill newborns *(ELMeneza & AbuShady 2020).* This environment increases the risk to neonates. The environmental factors include unpredictable workflow, a demanding workload, quickly changing neonate acuity, frequent distractions and interruptions, loud noise, and poor lighting. Many research demonstrates that distractions and interruptions during the medication administration process are major contributing factors to medication errors. The NICU fits the criteria for a high-risk setting requiring specialized care to minimize the danger of medication errors. Human factors including exhaustion, burnout, complacency, a false sense of security with technology, poor team communication, and intimidation may play a role in medication errors *(Elie et al., 2018).*

Technology can improve medication safety (e.g., bar code medication administration and prescriber order entry); checklists, standard formularies, and standard drug concentrations can be maintained; pharmacists on bedside rounds can improve medication safety. A multidisciplinary NICU team must be included, with a conscious, trained NICU nurse aware of the neonate's particular risk factors and the significant risk of medication errors in the NICU. Medication errors cannot be prevented only through technology. Rather, the most comprehensive strategy for reducing drug errors is a mix of an attentive NICU nurse, a dedicated NICU team, proper equipment, and a safety conscious NICU atmosphere *(Ni et al., 2018).*

Organizational health care must promote a patient safety culture by improving NICU staff communication and creating an environment that includes monitoring for medication error, reporting, tracking, and prevention management, possibly developing new strategies to improve existing practice. *(Melton et al., 2019).*

Neonatal nurses have very important responsibilities in preventing medication errors as they play a key role in the medication process. Neonatal nurses would need a very high level of knowledge of drugs. However, the increasing number of drugs available for administration in NICU, the nurses' responsibility for updating their knowledge of drugs has increased greatly. An important intervention to reduce medication errors is continuing education to improve knowledge of medications management and administration *(Rishoej et al., 2017).*

Research indicated that the active applications of nursing guidelines have increased and improved the knowledge and practice of nurses regarding HAMs. Nursing guidelines help nurses to accept responsibilities' for their professional development. The well trained neonatal nurse is the backbone of any health organization, so nursing guidelines that are highly effective in mitigating neonatal risk, increasing staff efficiency, promoting optimal neonatal outcomes, establishing consistent provision of high-quality care for high-risk neonates while saving the healthcare system time and money *(De Lima Costa et al., 2018).*

## 2. Significance of the study

The Egyptian National Online Reporting System reported that 23% of medications errors (MEs) came from intensive care units in Egypt. The most prevalent form of ME occurred during prescription (54 percent), followed by monitoring (25 percent) and administration (16 percent). The most frequent error was the wrong dose (20%), followed by medication interactions, a wrong medicine, and a wrong frequency. Only 13% of reported errors result in patient harm; the majority of reports were potential (25%), preventable (11%), or harmless (51%) errors. Antibiotics, cardiovascular drugs, and drugs acting on the central nervous system were the top three medication classes involved in reported MEs. Causes of MEs were mostly environmental factors, lack of knowledge, lack of drug information sources, and incomplete prescribing *(Shehata et al., 2016).*

Medication administration is one of the main functions of nurses in the NICU, so they need to know that medication obtains maximum benefit without any harm. In hospitals, medication administration errors are frequently utilized as indicators of neonatal safety because of their common occurrence and potential risk to neonates *(Engels & Ciarkowski, 2015).* The Egyptian Medication Errors Reporting System disclosed that the most frequent administration errors were extra dose, dose omission, and medication omission *(Shehata et al. 2016).* Therefore, applying nursing guidelines technique for neonatal nurses consequently decrease medication error, safe handling of HAMs, and enhancing their performance.

## 3. Aim of the study

The study aims to evaluate the effectiveness of nursing guidelines on neonatal nurses' performance regarding high alert medications through:

- Assessing neonatal nurses' knowledge regarding high alert medications.
- Assessing neonatal nurses' practice regarding the administration of high alert medications.
- Designing and implementing nursing guidelines for neonatal nurses to improve their knowledge and practice.
- Evaluating the effect of nursing guidelines on neonatal nurses' knowledge and practice in administering high alert medications.

### 3.1. Research hypothesis

The researchers hypothesized that

- Applying nursing guidelines to neonatal nurses would positively affect their knowledge and practices about high alert medications compared to their pretest.

- There will be a positive correlation between nurses' knowledge and practices score levels.

### 3.2. Operational definition

*High alert medications* are medicines that carry an increased risk of inducing significant patient harm when used in error.

*Guidelines* are acceptable practices and options, including pharmacological therapy, for managing a specific procedure or treatment for a certain diagnosis or condition, which can be used to aid clinical decision-making and fulfil patient's specific needs.

*Neonate* is a newborn infant less than one-month-old.

## 4. Subjects & Methods

### *4.1. Research Design*

Quasi-experimental research (one group pre/post-test) was used to achieve the aim of the current study.

### *4.2. Study setting*

The study was conducted at NICUs in Children's Hospital and the Maternity and Gynecological Hospital affiliated to Ain Shams University, where these settings have the highest capacity of neonates who receive high alert medication and many neonatal nurses.

### *4.3. Subjects*

A convenience sample involved all available neonatal nurses composed of 80 nurses working at the previously mentioned settings and were providing care for high-risk neonates.

*Inclusion criteria*

All nurses that agree to participate in this study, regardless of their age, gender, qualifications, and experiences, to study the effect of nursing guidelines regarding HAMs.

### *4.4. Tools of data collection*

Two tools were used for data collection pre and post the intervention of the nursing guidelines. The researchers designed the tools after reviewing the relevant resources and include the following:

#### 4.4.1. Structured Interview Questionnaire

It designed in Arabic language and used as pre/post-test format of the intervention, in the form of close-ended questions. It encompassed two main parts:

Part I consisted of seven questions concerned with the personal characteristics of the neonatal nurses, such as age, gender, marital status, qualification, years of experience, training courses, and working hours.

Part II included the knowledge assessment of the studied nurses. It included (17) questions in the form of multiple-choice questions, covering the questions related to; the definition and types of high alert medication (3 questions), precautions for high alert medications (6 questions), actions should be taken when errors happen with high alert medications (4 questions) and side effects of it (4 questions). The time consumed to fill in the questionnaire by nurses was 15-20 minutes. The researcher assessed the nurses two times through pre and post-test.

*Scoring system:*

The studied nurses' answers were checked using a model key answer. The questionnaire questions were scored as, the right answer was scored a one-point, and the incorrect answer was scored zero points. The total scores of the questionnaire were 17 grades. A total score of 17 grades equal to 100%. The score of the subsections and the total were presented as mean and SD.

#### 4.4.2. Nurses Performance Observation Checklists

It was adopted from *Greenberg et al. (2018)* in the English language and was used to assess neonatal nurses' practices regarding high alert medications. It included identification, ordering, and receiving of high alert medications (17 steps), preparing high alert medications (29 steps), administrating high alert medications (16 steps), documentation and reporting (11 steps), and storage of high alert medications (15 steps). Each nurse was observed three times using the observational checklists pre (three times) and post (three times) implementing the nursing guidelines by the same researcher. The three observations were summed, and the mean was taken.

*Scoring system*

The total number of steps was (88) items. The total score of nurses' practices was 88 grades (equal to 100%). Each step was evaluated as "done" that graded with one score, and "not done" that graded with zero scores. The score of the subsections and the total were presented as mean and SD.

### *4.5. Procedures*

Content validity and reliability: It was ascertained by five experts (3 professors in the pediatric nursing department at Ain Shams University, two professors in nursing administration departments at Ain Shams University). Content validity was assessed to determine whether the tool covers the appropriate and necessary content and its relevance to the aim of the study, accuracy, consistency, clarity, and simplicity of the tool. The suggested modifications were done (rephrasing some statements, omission, and addition of certain items. Then, the final form was stated. The study instruments were put to the Cronbach's Alpha test to see if they were reliable. It was 0.79 for the knowledge questionnaire and 0.82 for the practice checklist.

Preparatory phase included reviewing the available literature related to HAMs at NICU. It served to construct the data collection tools. In this phase, the researcher visited the selected setting to get acquainted with the personnel and the study settings.

An official permission by submission of a formal letter issued from the Dean of Faculty of Nursing, Ain Shams University, to the director of the previously mentioned setting to collect the necessary data for the current study

after a brief explanation of the purpose of the study and its expected outcomes.

Ethical Considerations: Before starting, the researchers have clarified the study's objectives and aim for nurses included in the study. Verbal approval was obtained from the neonatal nurses before intervention; according to their degree of knowledge, a clear and basic explanation was given. They ensured that all information acquired was kept confidential and solely used for research purposes. The researcher ensured maintaining anonymity and confidentiality of the subjects' data included in the study. The nurses were informed that they had the option of participating in the study or not and that they had the right to withdraw at any moment.

A pilot study was carried out on eight neonatal nurses, 10% of the studied sample in the previously mentioned setting, to test the applicability and the clarity of the study tools and the feasibility of the research process. The pilot has also served to estimate the time needed for each subject to fill in the study tools. The final form was achieved by re-arranging and modifying the tools' items based on the pilot study findings. The subjects of the pilot study were excluded from the study sample.

Fieldwork: The study was performed through three phases; assessment, implementation, and evaluation. These phases were carried out from the first week of January 2021 till the end of June 2021, covering six months. The researchers were available at the study settings alternately, three days/a week Saturday, Wednesday, and Thursday in the morning and afternoon shifts by rotation.

Assessment phase: The data was collected from the study subject using the tools designed to assess the neonatal nurses' knowledge deficit and practice deficit, pre-intervention information (pre-test). In the first session, the researchers explained the aim of the study and the components of the tools, as well as their approval to participate in the study, were obtained. The nurses' knowledge questionnaire was distributed to the nurses' to complete by themselves in the presence of the researchers to assess their baseline knowledge (pre-test) regarding HAMs and their learning needs. It took 15-20 minutes to fill out the questionnaire. Then the researcher observed the neonatal nurses before, during, and after administering neonates with HAMs using the observational checklists (Tool 2) three times. The time needed for each observation for each nurse was 20-25 minutes. The same researcher observed the nurses' practice for the same specified nurse during their practices. The mean of the three observations was summed after that, and then the mean was taken. Educational nursing guidelines were prepared and designed according to the neonatal nurses' level of knowledge and skills.

Implementation phase: Implementation of the nursing guidelines for neonatal nurses takes place during this phase. The researchers divided the studied subjects into small groups, ranging from four to six neonatal nurses in each setting. The intervention was implemented through five sessions covered the theoretical and practical parts. Two sessions about the theoretical background for high alert medication and three sessions about nurses' skills in high alert medication administration. The time of each session ranged from 20-30 minutes, including the time of discussion.

The intervention was implemented for each small group for ~~one~~ two weeks (3days/week). Each session started with a summary and feedback regarding the previous session. Simple Arabic terms were employed to suit the nurses' level of comprehension. Various instructional methods were employed (lectures, demonstration, and re-demonstration). During the execution of the guidelines, appropriate instructional aids were produced and used (proper equipment, real objects, and video film were used for the practical part). Learning activities are done inside each unit after the morning care and during the sleeping time of high-risk neonates. Nurses were motivated to cooperate and participate in activities during different stages of the study.

Nursing guidelines construction involved the following:

*Setting the Objectives:*

- The general objective of the nursing guidelines was to promote the neonatal nurses' performance regarding HAMs by providing the nurses with the correct knowledge and competent skills.
- Specific objectives of the nursing guidelines included the following:
  - Define high alert medications (HAMs).
  - List types of HAMs.
  - Explain the precautions when using HAMs
  - Describe actions that should be taken when errors happen.
  - Mention the side effects of HAMs.
  - Explain nursing intervention before, during, and after administration of HAMs.

According to the previously mentioned objectives, the theoretical content of the nursing guidelines was included: definition, types, precautions, actions that should be taken when errors happen, and side effects of high alert medications.

The practical content of the nursing guidelines was included: nursing intervention pre-administration of high alert medications (HAMs) which includes identification, ordering and receiving of HAMs. Nursing intervention during the administration of HAMs that included preparing HAMs, administering HAMs, and finally, nursing intervention post administration of HAMs which included documenting, reporting, and storing HAMs.

The implementation of the nursing guidelines was carried out in the previously mentioned settings. Neonatal nurses' knowledge and practice are evaluated pre-intervention to get a baseline assessment for neonatal nurses before developing the nursing guidelines and post-intervention using the same tools to determine the effect of implementing the nursing guidelines intervention.

*Evaluation phase:* the nursing guideline evaluation compared the neonatal nurses' knowledge and practices pre- and post-implementation. The researchers motivated the

studied nurses by encouraging words to gain their participation.

### *4.6. Data Analysis*

The collected data were revised, coded, cleaned, and entered a personal computer (PC). Statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS) version 22. The mean and standard deviation (SD) presented the data. A linear regression model is a linear approach to modeling the relationship between a scalar response and one or more explanatory variables; paired t-test and r-test are used to compare pre, and post-intervention. Statistical significance was considered at p-value ≤0.05.

## 5. Results

Table 1 shows that less than half (43.8%) of studied nurses aged ranged between 20 to less than 25 years with a mean of 27.79±6.83 years, less than two-thirds (63.7%) of them were females, and 58.8% were not married. Moreover, this table shows that half of the nurses (52.5%) had a technical nursing degree, and their mean of years' experience was 8.91±7.05 years.

Figure 1 shows that three quarters (75%) of studied neonatal nurses did not attend training courses about high alert medication

Figure 2 shows that most (65%) of studied neonatal nurses were working part-time.

Table 2 displays a highly statistically significant differences between pre and post-test mean scores of nurses' knowledge regarding the definition and types of high alert medications, precautions, actions that should be taken when errors happen, and side effects of high alert medications, and total knowledge (t=6.37, 9.55, 8.41, 11.28, 13.95, respectively at p<0.001).

Table 3 demonstrates a highly statistically significant differences between pre and post-test mean scores of all nurses' practice regarding identification, ordering, and receiving of high alert medications, preparing high alert medications, administrating high alert medications, documentation, reporting, storage of high alert medications, and total knowledge (t=12.65, 15.01, 9.38, 11.67, 13.21, 18.36 respectively at p<0.001).

Table 4 shows a highly statistically significant relationship between nurses' knowledge and practice after implementing the nursing guidelines with a p-value (p<0.001). At the same time, there is no statistically significant relationship between knowledge and practice pre-implementation of the nursing guidelines with a p-value (p>0.05).

Table 5 reveals a significantly higher frequencies of the effect of age, qualifications, marital status, years of experience, training courses, working hours, and practice level as a predictor of knowledge level (p<0.05). At the same time, gender was not ~~predicted by relation~~ a predictor to knowledge level (p>0.05).

Table 6 illustrates a significantly higher frequencies of the effect of age, qualifications, marital status, years of experience, training courses, working hours, and knowledge level as a predictor of practice level (p<0.05). In comparison, gender was not ~~predicted by relation~~ a predictor to practice level (p>0.05).

**Table (1): Frequency and percentage distribution of studied neonatal nurses according to their characteristics (n=80).**

| Characteristics | No | % |
|---|---|---|
| **Age** | | |
| 20-<25 | 35 | 43.8 |
| 25-<30 | 14 | 17.5 |
| 30-<35 | 11 | 13.7 |
| 35 or more | 20 | 25.0 |
| $\bar{x}$±S.D | 27.79±6.83 | |
| **Gender** | | |
| Male | 29 | 36.3 |
| Female | 51 | 63.7 |
| **Marital status** | | |
| Married | 33 | 41.2 |
| Not Married | 47 | 58.8 |
| **Qualifications** | | |
| Secondary nursing degree | 22 | 27.5 |
| Technical nursing degree | 42 | 52.5 |
| Bachelor nursing degree | 16 | 20.0 |
| **Years of Experience** | | |
| <5 years | 34 | 42.5 |
| 5-<10 years | 16 | 20.0 |
| 10-<15 years | 11 | 13.7 |
| >15 years | 19 | 23.8 |
| $\bar{x}$ S.D | 8.91±7.05 | |


**Figure (1): Percentage distribution of studied nurses regarding their attending training courses about high alert medication (n= 80).**

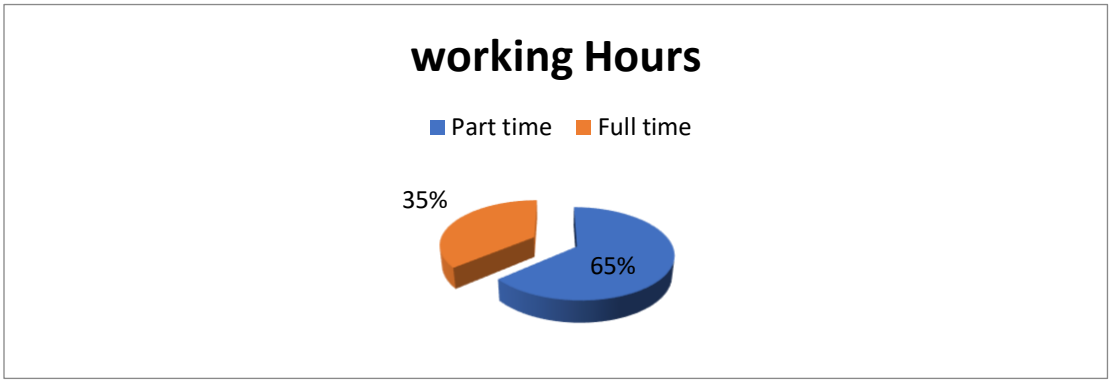


**Figure (2): Percentage distribution of studied neonatal nurses regarding their working hours (n= 80).**

**Table (2): Comparison of the studied nurses' knowledge mean scores pre/post the nursing guidelines intervention (n=80).**

| Items | No. of items | Pre-test | Post-test | t. test | p-value |
|---|---|---|---|---|---|
| Definition and Types of high alert medications | 3 | 1.26±0.74 | 2.77±0.91 | 6.37 | 0.01 |
| Precautions for high alert medications | 6 | 2.18±1.96 | 4.90±2.11 | 9.55 | 0.00 |
| Actions should be taken when errors happen with high alert medications | 4 | 1.83±1.74 | 3.00±1.86 | 8.41 | 0.00 |
| Side effects of high alert medications | 4 | 1.67±1.43 | 3.54±1.49 | 11.28 | 0.00 |
| **Total** | 17 | 6.59±3.22 | 13.08±4.19 | 13.95 | 0.00 |

**Table (3): Comparison of the studied nurses' practice mean scores pre/post regarding nursing guidelines intervention (n=80).**

| Items | No. of items | Pre-test | Post-test | t. test | p-value |
|---|---|---|---|---|---|
| Identification, ordering and receiving of high alert medications | 17 | 5.76±3.20 | 11.67±6.33 | 12.658 | 0.01 |
| Preparing high alert medications | 29 | 13.18±5.67 | 24.90±7.31 | 15.011 | 0.00 |
| Administrating high alert medications | 16 | 8.46±4.19 | 13.01±6.29 | 9.384 | 0.00 |
| Documentation and reporting | 11 | 4.55±3.18 | 8.33±3.56 | 11.673 | 0.00 |
| Storage of high alert medications | 15 | 6.82±2.55 | 12.41±5.72 | 13.213 | 0.00 |
| **Total** | 88 | 38.21±8.39 | 73.08±12.66 | 18.364 | 0.00 |

**Table (4): Correlation between the total mean score of nurses'' knowledge and their total practices pre/post-intervention nursing guidelines (n=80).**

| Items | | Knowledge | | | |
|---|---|---|---|---|---|
| | | Pre | | Post | |
| | | r-test | P. value | r-test | P-value |
| Practices | Pre | 0.195 | 0.081 | --- | --- |
| | Post | --- | --- | 0.911 | <0.001 |

**Table (5): Predictors of nurses' knowledge levels revealed by multiple linear regression model.**

| Predictors* | Unstandardized Coefficients | standardized Coefficients | t-test | P. value |
|---|---|---|---|---|
| | *B* | B | | |
| Age | 0.461 | 0.454 | 7.482 | 0.014 |
| Gender | 0.108 | 0.154 | 2.825 | 0.051 |
| Qualifications | 1.24 | 0.717 | 16.407 | 0.000 |
| Marital status | 0.654 | 0.656 | 6.351 | 0.012 |
| Years of experience | 0.702 | 0.708 | 11.300 | 0.005 |
| Training courses | 0.809 | 0.417 | 14.001 | 0.001 |
| Working hours | 0.466 | 0.510 | 5.164 | 0.011 |
| Practice level | 1.146 | 0.811 | 14.251 | 0.001 |

**Model summary**

| Model | r | r square | Adjusted r square | Std. error of estimate |
|---|---|---|---|---|
| Regression | 0.954 | 0.912 | 0.864 | 0.524 |

*a. Dependent Variable: Knowledge level*

*b. Predictors: (constant) age, gender, qualification, marital status, years of experience, training courses, working hours, and practice level.*

**Table (6): Predictors of nurses' practice levels revealed by multiple linear regression model.**

| Predictors* | Unstandardized Coefficients | standardized Coefficients | t-test | P. value |
|---|---|---|---|---|
| | *B* | B | | |
| Age | 0.385 | 0.374 | 8.133 | 0.018 |
| Gender | 0.098 | 0.111 | 1.564 | 0.064 |
| Qualifications | 0.567 | 0.434 | 9.460 | 0.007 |
| Marital status | 0.154 | 0.231 | 5.024 | 0.014 |
| Years of experience | 0.988 | 0.810 | 14.260 | 0.001 |
| Training courses | 0.819 | 0.499 | 11.370 | 0.003 |
| Working hours | 0.793 | 0.688 | 8.033 | 0.009 |
| Knowledge level | 1.699 | 0.641 | 15.201 | 0.000 |

**Model summary**

| Model | r | r square | Adjusted r square | Std. error of estimate |
|---|---|---|---|---|
| Regression | 0.894 | 0.799 | 0.751 | 0.434 |

*a. Dependent Variable: Practice level*

*b. Predictors: (constant) age, gender, qualification, marital status, years of experience, training courses, working hours, and knowledge level*

## 6. Discussion

High alert medications (HAMs) are among the pharmaceuticals with the highest risk of serious harm if delivered incorrectly, and they are responsible for the most dangerous errors. The administration of HAMs is the responsibility of nurses; improper administration can have serious clinical consequences and, in certain cases, can be fatal *(Shawahna et al., 2016).* This study aimed to evaluate the effectiveness of nursing guidelines on neonatal nurses' performance regarding HAMs.

The characteristics of studied neonatal nurses in the present study reveal that less than half of their ages ranged from 20 to less than 25 years, with a mean of 27.79±6.83 years, less than two-thirds of them were females, which might be due to the greater fraction of the nurses in Egypt were females and also related to the studying of nursing in the Egyptian universities was exclusive for females only till fifteen years ago. Half of the nurses had a technical nursing degree and the mean of years' experience of them was 8.91±7.05 years. This finding might be because fresh graduates and young nurses usually work in NICUs and emergency departments.

These results were supported by the study conducted by *Zaki et al. (2018)* titled "Assessment of nurses' performance regarding care for neonates with necrotizing enterocolitis at Intensive Care Units" at Benha Specialized Pediatric Hospital, who detected that the mean age of nurses was 25.93±4.36 and more than two-thirds of them had a secondary school diploma and technical institute diploma. However, these results are inconsistent with the study performed by *Ali et al. (2019)* titled in "Improving nursing knowledge and care for neonates with respiratory distress in Jordan", who reported that the mean age of neonatal nurses was 32.23±5.01 years, almost of them had bachelor's degree with 6.5±4.4 mean years of experience.

Also, it was clarified that three-quarters of the studied nurses did not attend training courses regarding high alert medications, and most of them were working part-time, respectively. This finding was contradicted by *shittaya (2020),* who conducted a study about "Performance of nurses regarding high alert medications in critical care units" and mentioned that more than two-thirds of the studied nurses did not attend training courses regarding high alert medications, and most of them were working as full-time workers.

Regarding the neonatal nurses' knowledge about HAMs, there was a marked improvement in their total knowledge post-implementation of nursing guidelines compared to their pre-test with a highly statistically significant difference at (P= < 0.001). From the researchers' point of view, this improvement is due to nurses' reluctance to obtain information on how to prepare, administer, and store high alert medications and use of visual aids during guidelines implementation to clarify the information. The

nursing guidelines shed light on milestones for high alert medication administration.

This result is similar to the study conducted by *Sullivan et al. (2021)* titled "Enhancing high alert medication knowledge among pharmacy, nursing, and medical staff", which reported that before the HAMs interventions, more than one-third of respondents expressed confidence in their knowledge of high alert medication and the procedures defined by the institution. This result increased to less than three quarters after the interventions ($p$<0.001). Also, in line with the study conducted by *Ameri et al. (2016)* in a study carried out in Sarem Maternity Hospital in Tehran, Iran about "Effect of a comprehensive total parenteral nutrition training program on knowledge and practice of nurses in NICU" who reported that nurses' knowledge and practice outcomes improved significantly as a result of the program.

Regarding the neonatal nurses' practice of HAMs, the current study revealed a marked improvement in their practice level in identification, ordering, receiving, preparing, administrating, documenting, reporting, and storage of HAMs with a highly statistically significant difference at (P < 0.01). These results may reflect that the guidelines were prepared based on nurses' needs assessment and according to pre-test level of nurses, using illustrative methods, demonstration & re-demonstration, and the allowing of questions to get nurses' feedback and group discussion.

These results are consistent with the study performed by *Soomar et al. (2019)* in Pakistan titled "Medication errors in neonatal intensive care unit and strengthening the education of registered nurses." Also, it supported by the *Falts and Fathy (2017)* study that carried out in the coronary care units and respiratory intensive care units at Ain Shams University Hospital about "High alert medications: The effect of nursing guidelines on internship nursing students' performance", who reported significant improvements in the level of performance of internship nursing students (P< 0.05). These findings support the first research hypothesis.

The current study's correlation between the total mean score of knowledge and practice shows a highly statistically significant relationship between nurses' knowledge and practice after implementing the educational guidelines (p<0.001). This finding clarifies that these nurses' practices are directly influenced by their knowledge, and knowledge is essential to achieving competent practices. These findings supported the second research hypothesis.

These results are supported by the study performed by *Zyoud et al. (2019)* titled "Knowledge about the administration and regulation of high alert medications among nurses in Palestine: A cross-sectional study", who detected a significant correlation between knowledge related to high alert medication and administration of it. Also, *Yousef et al. (2018)*, carried out a study in Cairo about the "Effect of nursing education guidelines about high alert medications on critical care nurses' knowledge and practices" and found a high positive correlation between nurses' knowledge and their practice regarding high alert medication.

Regarding the linear regression model, the present study reveals significantly higher frequencies of the effect of age, qualifications, marital status, years of experience in training courses, working hours, and practice level as predictors of knowledge level (p ≤0.05). At the same time, gender was not revealed as a predictor for knowledge (p >0.05). These results is similar to the study conducted by *Labib et al. (2018)* carried out in NICU at Cairo University Pediatric Hospital about "High alert medications administration errors in neonatal intensive care unit", who reported non-significant, negative relationships were observed when correlating knowledge scores with nurses' age, total and NICU experience years. Also, it supported with *Engels and Ciarkowski, (2015)* about "Nursing, pharmacy, and prescriber knowledge and perceptions of high-alert medications in a large, academic medical hospital", who detected that training courses had high effect on nurses' knowledge. The study disagrees with a study conducted by *Zyoud et al. (2019)*, who found significant differences in knowledge scores according to gender.

Regarding the linear regression model, the present study illustrates a significantly higher frequency effect of age, qualifications, marital status, years of experience, training courses, working hours, and knowledge level as predictors on practice level (p≤0.05). At the same time, gender is not a predictor to practice level (p >0.05). These results agree with the study conducted by *Labib et al. (2018)*, who reported a moderate positive relationship between the post-administration practices score and nurses' age and no relation to gender. Also, consistent with the *Dehghan-Nayeri et al. (2013)* study that carried out in Tehran about "The effectiveness of risk management program on pediatric nurses' medication error", who revealed that qualification of nurses had a high effect on their practice regarding high alert medication**.**

## 7. Conclusion

In light of the study findings, the implementation of nursing guidelines positively affected neonatal nurses' knowledge and practice related to high alert medications. Also, there the study revealed a positive correlation between nurses' knowledge and practices score levels and the research hypotheses are accepted.

## 8. Recommendations

Based on the findings of the present study, it recommends the following:

- Conducting periodic in-service educational training as nursing guidelines for neonatal nurses to improve their knowledge and practices regarding high alert medications.
- Our findings highlight the need for additional research on interventions to reduce HAMs errors. For better disease outcomes, continuous education programs regarding the safe handling of HAMs. Integration of topics about the administration of HAMs in the nursing curriculums for

different categories (Secondary school diploma, technical, and bachelor).
- Continuous and mandatory in-service training for healthcare workers dealing with HAMs (preparation, administration, storage). The nursing staff is involved in developing, implementing, and evaluating medication delivery systems used in the NICU.
- Appropriate workplace policies and procedures for the safe handling of HAMs should be developed and reviewed based on international safety standards/guidelines.
- Further research: Replication of the research on a more substantial probability sample to achieve more generalization.

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