Effect of Educational Instructions on Nurses' Performance Regarding Common Alarms Indicators at Neonatal Intensive Care Unit

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Abstract

Background: Clinical alarms, particularly in neonatal Intensive care units, are vital for alerting healthcare providers when a neonate requires immediate attention. Fatigue from alarms occur when nurses are subjected to plenty of numerous alarms, resulting ignorance, postponed reaction to alarms that may result in severe health problems to neonates. **Aim:** Evaluate the effect of educational instructions on nurses' performance regarding common alarms indicators at neonatal intensive care unit. **Subjects and Method**: **Design**: A quasi- experimental research design was used **Sample:** A convenience sampling of (70) nurses who are working at Neonatal Intensive Care Unit of Tanta Main University Hospital were included. **Tools:** two tools were used, **Tool I:** Nurses' knowledge questionnaire regarding Common Alarms Indicators **Tool II:** Common Alarms Indicators Observation Checklists. **Results**: Most of the studied nurses had moderate level of knowledge and the majority of them had unsatisfactory practices pre educational instruction, whereas immediately following the educational instruction and after one month, the majority of nurses had high knowledge and satisfactory practice. **Conclusion**: There was a notable improvement in nurses' performance regarding common alarms indicators at Neonatal Intensive Care Unit. **Recommendations:** Performing recurring training in service education as nursing guidelines for nurses at Intensive Care Units to improve their knowledge and practices regarding devices alarms management.

Keywords: Common alarm indicators, Educational instructions, Neonatal Intensive Care Unit, Nurses' performance**.**

Introduction

Neonatal Intensive Care Units depends basically on biomedical devices and instruments for monitoring, diagnosisand treatment of neonates. The primary devices cause alarms in critical care units are monitors, mechanical ventilators, syringe pumps, incubators and infusion pumps. Medical devices have unique properties and few that are coordinated in a clinical context as the manufacturer, the kind of device, the alarm arrangement settings, and the care unit which affect how alarms are distributed **(ELMeneza et al., 2020; Keya et al., 2024)**.

Neonatal Intensive Care Units deliver top-notch healthcare to critically ill newborns. Most of the pediatric patients include premature infants, with undeveloped physiological functions, at high danger of making significant issues which include necrotizing enterocolitis, bronchopulmonary dysplasia or retinopathy of prematurity. This newborn patients often need ventilator-assisted breathing and intravenous feeding and medicine through infusion pumps To identify potentially important incidents, physiological cues **(Varisco etal., 2021; Varisco, 2023)**.

Monitoring devices are accountable for generating a great quantity of alarms. Among the most prevalent alarms at the NICU related to monitors are peripheral oxygen saturation, heart rate and noninvasive blood pressure. The most common ventilator alarms are disconnection, low pressure, high pressure, apnea and no gas delivery. Syringe pump alarms are occlusion, system error, nearly empty and low battery. Infusion pump alarms are occlusion, end infusion and tubes air, rate and time alarms. Incubator alarms are high temperature, low temperature, system alarm and sensor alarm **(Walsh & Waugh, 2020;Varisco et al., 2021)**.

Neonates at ICU care gadgets have visual and auditory indicators that flash and emit alerts such as alarms alert nurses that a newborn may experience a problem and need clinical care intervention. Alarms are seen as a significant burden in NICUs because they can increase cardiorespiratory instability, generate stress on newborn, and disrupt neonate' sleep **(Watson& Edmonson, 2020; El-Dib et al., 2023)**.

Alarm is known to interfere with leisure, sleep and ignorance could result in long-term loss of hearing and has been estimated as a possible danger factor for more severe neurological development. On the other hand, substantial sound exposure, like music or language, may enhance preterm newborns' neural connectivity and language abilities, whereas auditory deprivation seems to be one of the most major causes of adverse neurological outcomes **(Restin et al., 2021)**.

Since these alarms both interrupt neonates' sleep and raise their stress levels, they are a serious worry.

Encountered by both their parents and the hospital staff. Fatigue from alarms occur when care providers are subject to plenty numerous alarms, resulting ignorance, Postponed reaction to alarms that may result in severe healthy problems to neonates. False alarms are to blame for decreasing nurses' response time and confidence in the alarms. Specifically, when Intensive Care Unit performs care in different rooms for patient, alarm controlling is a security issue, as care provider are not consistently beside each neonates' bed. In that situation, central observation and alerting on mobile resolutions would need to send alarms to the care provider wherever they are **(Varisco etal. 2021; Varisco, 2023)**.

Advanced care is provided to critically unwell neonates in critical care units, where neonate condition is closely monitored round-the-clock. Nurses depend mainly on the medical alerts of the different surveillance tools. Numerous elements, including the department's policy, practice of nursing and technology, can impact the efficacy of alarm management at the Neonatal Intensive Care Unit **(Lee et al., 2021)**.

Nursing practice must be improved systematically to a higher standard. In order to provide safe and effective care, neonatal nurses must comprehend the difficulties of caring for each neonate who requires care. The best possibilities for care in the area can be found in an integrated and interconnected compilation of theories, procedures, strategies, and activities that make up nursing practice improve while preserving the consistency with knowledge, situations, values, surroundings, goals and evidences in the benefit of health. **(Thabet, Zakie, Sayed, Mahmud & Masood, 2021; Schlesinger, et al ., 2018)**

This circumstance is not unexpected since alarm pressure can be enormous and a resolve of each alarm unrealistic within the constraints of the typical clinical worktop. It is essential to proper dealing with the alarms in intensive care units in order to reduce workflow disturbances by appropriately handling alerts. **(Joshi et al ., 2019).**

The primary objective of this research is to detect nurses in the NICU and to evaluate their interventions and dealing with the alarms or pre-scheduled actions and effective alarm management at NICU is to create a safety environment to newborn. Nurses must record all alarms that may occur in NICU, and guaranteed the nurses' behavior that attentive the observed neonates (**Sheng et al., 2022).**

Significance of the study

Alarm is an important indispensable and lifesaving indicator. The clinical alarms are used to make sure that nurses are informed when a neonate needs urgent care. Neonates' condition may change suddenly and necessitate immediate emergency medical intervention, or it may develop gradually and not be immediately

apparent but can be identified by analyzing multiple vital parameters. **(Bosma, & Christopher, 2023)**.

Nurses must interpret and respond to alarm signals because they are continually exposed to them. All while completing their usual neonatal care duties alarm management, which attempts to lower the quantity of needless alerts (that is, false, non-actionable, and preventable technical alarms), is one strategy to lessen the harm connected with clinical alarms **(Wunderlich et al,2024 ; Poncette et al, 2021).**

Continuing education to increase management knowledge is a crucial measure to lower errors of devices alarms. Also, there are little researches focused on nurses' performance regarding devices alarms management in Neonatal Intensive care units. Thus the aim of the study is to evaluate the effect of educational instructions on nurses' performance regarding common alarms indicators at Neonatal Intensive Care Units **(Irawati, Grüner-Nielsen, Rishøj & Rottwitt., 2023).**

Aim of the Study is to:

Evaluate the effect of educational instructions on nurses' performance regarding common alarms indicators at NICU**.**

Research hypothesis

Nurses' performance regarding common alarms indicators at neonatal intensive care unit is expected to be improved after implementation of educational Instructions**.**

Subject

Research design:

A quasi- experimental research design was used in the present study.

Setting:

The study was carried out at Neonatal Intensive Care Unit of Tanta Main University Hospital which is affiliated to Ministry of Higher Education and scientific Research. It consisted of five rooms, room (1) contained four incubators, room (2) contained eight incubators and room (3) involved twelve incubators, room (4) contained eight incubators and room (5) contained four heaters. The rooms were equipped with phototherapy device, monitor, pulse oximeter, glucometer, infusion pump, syringe pump and mechanical ventilators.

Subjects:

A convenience sampling of (70) nurses who were working in Neonatal Intensive Care Unit of Tanta Main University Hospital.

Tools of data collection:

Two tools were used to collect the required data

Tool I: Nurses' knowledge questionnaire regarding Common Alarms Indicators: It was established by the researcher after reviewing the relevant literatures **(Koomen et al., 2021& Varisco et al., 2021)**. It was divided into two parts:

Part I: Socio-demographic characteristics of the studied nurses:

It was included: age, sex, marital status, and years of experience, education, and prior training.

Part II: Nurse's Knowledge about Alarms indicators

It was employed to evaluate nurses' Knowledge of alarms indicators such as definition of alarms, How to operate mechanical ventilators, mechanical ventilator indications, types of ventilator alarms, Causes and management of ventilator high and low pressure, ventilator low pressure management, high respiratory rate and apnea alarm, alarms ignorance associated problems, types of syringe pump alarm, causes and management of infusion pump alarms, ways to get rid of low battery alarm of infusion pump , causes and management of heart rate monitor alarms. It consisted of 21 items.

Nurses' knowledge was scored as following:

- Correct and complete answer was scored (2) marks
- Correct and incomplete answer was scored (1) mark.
- Wrong answer or don't know was scored (0)

The total scores of Nurses' knowledge calculated and classified into

-High level of knowledge was considered from 80% and more.

- Moderate level of knowledge was considered from 60 to lower than 80%.
- Low knowledge was regarded as inferior to 60%.

II- Common Alarms Indicators Observation Checklists:

It was developed by the researcher after reviewing the related literatures **(Koomen et al ., 2021 ; Sheng et al., 2022 ; Thabet, Zakie, Sayed, Mahmud & Masood, 2021)** to assess level of nurses' practice regarding common alarms indicators it was consisted of 5 main practices as follow:

1) Ventilator troubleshooting alarms (5 Items)

-Low Positive End-Expiratory Pressure
-Apnea
-High-Pressure Limit
-No Gas Delivery to the Patient (Disconnection)
-Low or High Fraction of Inspired Oxygen (FIO2)

2) Infusion pump troubleshooting alarm (4 Items)

- Low Battery alarm
-Occlusion alarm
-Tubing air
-Rate, frequency and time

3) Syringe pump troubleshooting alarm (4 Items)

- battery Ending
- Occlusion
- Nearly empty
- Near system error

4) Monitor troubleshooting alarms (4 Items)

- oxygen saturation alarm
- Heart rate alarm
- Non-invasive blood pressure alarm
- Electrocardiogram

5) Incubator troubleshooting alarms (4 Items)

- Over temperature
- Low temperature
- System alarm
- Sensor alarm

Total scores of nurses' practice calculated and classified into:

- Equal and more than 80% of total score represented satisfactory practice.

-Less than 80% of total score represented unsatisfactory practice.

Each item was scored as follows:

- Done (1).
- Not done (0).

Method

-An official permission for data Collection was obtained from the Dean of the Faculty of Nursing, Tanta University written to the administrators in Neonatal Intensive Care Unit of Tanta Main University Hospital to take their consent and collaboration to conduct this research.

-Ethical and legal considerations:

-An ethical Permission was obtained from the Faculty of Nursing Scientific Research Ethics Committee **(code 252-5-2023)**.

-Nature of the study was not cause any harm or pain to the entire sample.

-Confidentiality and privacy were taken into consideration regarding the data collection.

-Written informed consent was taken from the studied nurses

-Tools development: the study **tool (I)** was developed based on review of related literature to assess nurses' knowledge regarding common alarms indicators at neonatal intensive care unit.

-Nurses' practices regarding common alarms indicators observation checklists were assessed **using tool (II).**

-Content validity: A panel of five specialists in the field were revised the study tools to assess content validity, comprehensibility, applicability and ease of administration. The content validity index was 98.5%.

-A pilot study was carried out on seven nurses (10%) to test the tool for its' clarity, applicability, feasibility and the necessary modification were done. Pilot study was excluded from the actual sample of the study.

-Reliability of the tools: the Chronbach alpha coefficient test was used to assess the tools' reliability. The results showed that the nurses' knowledge regarding devices alarms was 0.789, The Chronbach alpha coefficient test was 0.932 for total items of nurses' practice regarding common alarms indicators.

-The researcher collected the data for six months started from October 2023 to April 2024. The researcher was available for the morning shift two days a week according to the prerequisites.

-questionnaire was filled in the clinical area by the studied nurses in presence of the researcher (Tool I) part 1 was filled pre the educational intervention while part 2 was filled pre & post and post one month of the educational instruction by nurses while observation checklists were filled by the researcher pre & post and

post one month the educational instruction

-The study was conducted in four phases of nursing intervention Including assessment, planning, implementation and evaluation phase.

The steps of the educational instruction included four phases:

1-Assessment Phase:

The researcher conducted interview with each study participant in order to get socio-demographic data of nurses, to assess nurses' knowledge regarding common alarms indicators at Neonatal Intensive Care Units by using (Tool I) and assess nurse's Practices regarding common alarms indicators for neonates connected with devices by using (Tool II)

2-Planning Phase:

Educational Instructions planned based on the needs assessment and literatures review, which includes the following:

- Setting specific objectives.

-Getting ready of the content and suitable Teaching method such as (lecture, video, power point presentation and posters).

- Different approach and resources for educational interventions were used including lectures and conversation in the group.

3-Implementation Phase:

The studied nurses were separated into ten subgroups, every group (7 studied nurses), educational instructions were carried out for each subgroup and time 30 to 45 minutes was allotted for each session. Four educational sessions were included in the study. Nurses were attended four sessions.

-The duration of data collection was within six months.

The first session: was focused on alarms' definition, importance and types.

The second session: was concentrated on causes and management of Ventilator alarms.

The third session: was concentrated on causes and management of infusion pump and syringe pump alarms.

The Fourth session: was concentrated on causes and management of monitor and incubator alarms.

4-Evaluation Phase: this phase was constructed to evaluate the effect of educational instructions on Nurses' knowledge and practices regarding common alarms indicators at Neonatal intensive care units. Evaluation was done before, immediately and one month later educational instruction implementation by use (tool I and tool II)

Statistical Analysis:

Data entry and analysis were done using SPSS version 23(Statistical Package for Social Science). The range, mean, and standard deviation were estimated for quantitative data. Regarding qualitative data, which use frequency to characterize a category set of data The Chi-square test, was utilized to contrast two groups, calculate the percentage or proportion of each category, and more (χ^2). The

Z value of the Wilcoxon Signed Ranks Test was used to compare the means of two related groups (before and after intervention program) of non-parametric data. When comparing more than two non-parametric data means, Correlation between variables was evaluated using Pearson's correlation coefficient (r).

Results

Table (1) :demonstrates the percentage distribution of the studied nurses according to their socio-demographic characteristics. It was observed that, the age of nurses was ranged from 23-45 years with the Mean ±SD: 31.02± 4.82. It was found that 84.3%, 75.7% are females and married respectively. Considering the educational level, it was clear that half of nurses (50%) completed their technical nursing education and 44.3% of them had bachelor's degree in nursing. The table also shows that 32.9% of nurses had less than 5 years of experience and 37.1 % their experience ranged from 5 to less than 10 years. All the studied nurses didn't receive any training regarding common NICU alarms.

Table (2) :clarifies the percentage distribution of the studied nurses' knowledge regarding ventilator and syringe pumps' alarms. It was found that more than half of nurses (58.6%) had incomplete correct answer about definition of Neonatal Intensive Care Units' alarms in pretest while, 97.1% & 92.9% had complete correct answers immediately after and post one month of the educational instructions respectively. There was a noteworthy variations between pre-immediate and pre - after one month (P= 0.0001).

In relation to nurses' knowledge regarding syringe emptiness alarms, it was found that less than two thirds of nurses (61.4%) had incomplete answer regarding syringe pump emptiness alarm in pretest while, 97.1% & 85.7% had complete correct answers during the immediate and follow up posttest of the educational instruction respectively. The study also reveals a significant statistically difference during all the study phases (P1=0.001, P2=0.0001 & P3= 0.009) respectively.

Table (3): shows percentage distribution of nurses' knowledge regarding infusion pump, monitor and incubator alarms. It was realized that more than half of studied nurses (57.1%) mentioned incomplete answers about causes of infusion pump alarms during pretest. However, 92.9% & 75.7% had complete and accurate answer right away after the educational instruction and one month later respectively. The study also demonstrated a significant difference during all phases of the study respectively (P1= 0.0001, P2= 0.0001 & P3= 0.044).

As regards nurses' knowledge about prevention of incubators' low temperature alarm. The findings showed that below two-thirds of the studied nurses (62.9%) had incomplete answer pre instructions.

Whereas, 85.7% & 84.3% had correct answer immediately and post one month test of educational instruction implementation respectively.

Table (4) :describes the percentage distribution of the studied nurses according to their total knowledge scores about common alarms indicators. It was observed that most nurses (88.6%) had moderate level of knowledge before educational instruction, while the majority of them (94.3% & 90%) had high level of knowledge immediately post educational instruction and post one month after educational instruction. There were statistically significant differences during the three phases of educational instructions ($p<0.05$).

Table (5): percentage distribution of nurses' practices subitems scores regarding common devices alarms. It was found that 95.7 % of nurses had unsatisfactory practice regarding ventilator alarms pre educational instructions while, 94.3 % & 87.1 % did well right immediately after and after one month respectively. Regarding infusion pumps' alarms, it was clarified that, 97.1% of nurses had unsatisfactory practice prior educational sessions whereas, 95.7 % & 94.3% had satisfactory practice immediately after and post one month of educational instructions implementation respectively. Statistically significant difference regarding nurses, practices toward syringe pump, monitor and incubator alarms pre, both immediately and a month after of the instruction application (P1=0.0001, P2= 0.001, P3=0.003 & P1=0.0001, P2=0.001, P3=0.003 & P1=0.001, P2=0.0001, P3=0.0001) respectively.

Table (6): shows the percentage distribution of the studied nurses according to total practices scores. It was noticed that majority of nurses (94.3%) had unsatisfactory practice before educational instruction, while 95.7% & 90% had satisfactory practice immediately post educational instruction and one month later respectively. There was statically significant difference before, instantly and one month following the application for educational instruction, respectively (P1=0.001,P2= 0.001,P3= 0.001).

Table (7): shows the Correlation between total nurses' knowledge and total nurses' practice score. It was found that statistically significant correlation between nurses, knowledge and practice shortly following the implementation of the instructional instructions (r=0.0303, p= 0.014). The table also clarified a significant correlation between total practice scores and total knowledge scores one month after the instruction sessions (r = 0.313, p= 0.008).

Table (1) Percentage Distribution of the Studied Nurses according to their Socio-demographic Characteristics.

The studied nurses (n=70)		
Socio-demographic characteristics	**No**	**%**
Nurses' Age (in years)		
20 < 30	29	41.4
30 - < 40	36	51.5
≥ 40	5	7.1
Range: 23-45 **Mean ±SD:** 31.02± 4.82		
Gender		
Male	11	15.7
Female	59	84.3
Marital Status		
Married	53	75.7
Single	13	18.5
Widow	2	2.9
Divorced	2	2.9
Educational Level		
Technical nursing	35	50
Bachelor in nursing	31	44.3
Postgraduates	4	5.7
Experience (in years)		
< 5	23	32.9
From 5:< 10	26	37.1
10 & more	21	30
Range: 2-21 **Mean & SD:** 8.54±3.21		
Previous workshops about common alarms at NICS		
No	70	100
Yes	0	0.0

Table (2): Percentage Distribution of the Studied Nurses' Knowledge Regarding Ventilator and Syringe Pumps' Alarms

Studied Nurses no (70)																					
Knowledge items	Pre						Immediately						After one month						Chi-square test		
	Correct answer		Incomplete answer		Wrong answer		Correct answer		Incomplete answer		Wrong answer		Correct answer		Incomplete Answer		Wrong answer		X^2 (1) P (1)-value	X^2 (2) P(2)-value	X2 (3) P(3)-value
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	No.	%	No.			
Definition of alarms	26	37.1	41	58.6	3	4.3	68	97.1	2	2.9	0	0.0	65	92.9	5	7.1	0	0.0	16.99 0.0001*	16.99 0.0001*	13.62 .001
Way of ventilator work	23	32.9	45	64.3	2	2.9	68	97.1	2	2.9	0	0.0	66	94.3	4	5.7	0	0.0	19.44 0.001*	14.74 0.001*	12.49 0.001*
Mechanical ventilator indications	25	35.7	43	61.4	2	2.9	64	91.4	6	8.6	0	0.0	55	78.6	15	21.4	0	0.0	20.43 0.0001*	27.23 0.0001*	13.98 0.001*
Types of ventilator alarms	27	38.6	41	58.6	2	2.9	68	97.1	2	2.9	0	0.0	67	95.7	3	4.3	0	0.0	16.94 0.001*	44.54 0.0001*	8.25 0.039*
Ventilator high pressure causes	25	35.7	44	62.9	1	1.4	62	88.6	8	11.4	0	0.0	62	88.6	8	11.4	0	0.0	20.23 0.001*	40.82 0.0001*	2.34 0.164
Management of ventilator high pressure	27	38.6	41	58.6	2	2.9	68	97.1	2	2.9	0	0.0	60	85.7	10	14.3	0	0.0	14.86 0.001*	52.16 0.0001*	11.64 0.003*
Ventilator low pressure management	24	34.3	42	60.0	4	5.7	67	95.7	3	4.3	0	0.0	59	84.3	11	15.7	0	0.0	15.99 0.001*	53.36 0.0001*	10.55 0.003*

Cont. Table (2)

Studied Nurses no (70)																					
Knowledge items	**Pre**						**Immediately**						**After one month**						**Chi-square test**		
	Correct answer		**Incomplete Answer**		**Wrong answer**		**Correct Answer**		**Incomplete answer**		**Wrong answer**		**Correct answer**		**Incomplete answer**		**Wrong answer**		**X^2 (1) P (1)-value**	**X^2 (2) P(2)-value**	**X2 (3) P(3)-value**
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**No.**	**%**	**No.**			
High respiratory rate alarm	25	35.7	42	60	3	4.3	66	94.3	4	5.7	0	0.0	64	91.4	6	8.6	0	0.0	11.75 0.003*	32.40 0.0001*	7.63 0.04*
Management of apnea alarm	32	45.7	36	51.4	2	2.9	65	92.9	5	7.1	0	0.0	57	81.4	13	18.6	0	0.0	13.81 0.001*	26.46 0.0001*	12.87 0.002*
Alarms ignorance associated problems	24	34.3	44	62.9	2	2.9	63	90	7	10	0	0.0	54	77.1	16	22.9	0	0.0	17.45 0.0001*	26.33 0.0001*	13.81 0.001*
Types of syringe pump alarm	22	31.4	45	64.3	3	4.3	63	90	7	10	0	0.0	62	88.6	8	11.4	0	0.0	11.59 0.005*	12.41 0.002*	10.68 0.005*
Management of syringe pump occlusion alarms	31	44.3	37	52.9	2	2.9	65	92.9	5	7.1	0	0.0	60	85.7	10	14.3	0	0.0	12.67 0.002*	13.67 0.001*	7.31 0.041*
Dealing with syringe pump emptiness alarm	25	35.7	43	61.4	2	2.9	68	97.1	2	2.9	0	0.0	60	85.7	10	14.3	0	0.0	15.48 0.001*	18.82 0.0001*	9.72 0.009*

Chi Square Test * Significant at P<0.05 P1. Before &one month after P2. Before and immediately post P3. Immediately post & one month after

Table (3): Percentage Distribution of Nurses' Knowledge regarding Infusion Pumps, Monitor and Incubator Alarms

Knowledge items	The Studied nurses (70)																				
	Pre						Immediately						After one month						Chi-square test		
	Correct answer		Incomplete answer		Wrong answer		Correct answer		Incomplete answer		Wrong answer		Correct answer		Incomplete answer		Wrong answer		X^2 (1) P (1)-value	X^2 (2) P(2)-value	X2 (3) P(3)-value
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	No.	%	No.			
Causes of infusion pump alarms	26	37.1	40	57.1	4	5.7	65	92.9	5	7.1	0	0.0	53	75.7	17	24.3	0	0.0	16.03 0.0001*	15.78 0.0001*	6.73 0.044*
Management of infusion pump occlusion alarm	28	40.0	41	58.6	1	1.4	67	95.7	3	4.3	0	0.0	54	77.1	16	22.9	0	0.0	13.80 0.003*	18.10 0.001*	6.24 0.042*
Ways to get rid of low battery alarm of infusion pump	26	37.1	43	61.4	1	1.4	61	87.1	9	12.9	0	0.0	53	75.7	17	24.3	0	0.0	8.36 0.012*	13.73 0.001*	8.24 0.034*
Causes of heart rate monitor alarm	22	31.4	46	65.7	2	2.9	59	84.3	11	15.7	0	0.0	56	80.0	14	20.0	0	0.0	13.48 0.0001*	15.78 0.0001*	6.38 0.045*
Management of monitor alarms	26	37.1	41	58.6	3	4.3	62	88.6	8	11.4	0	0.0	54	77.1	16	22.9	0	0.0	12.10 0.001*	14.94 0.001*	9.83 0.007*
Prevention of incubator's high temperature alarm	29	41.4	39	55.7	2	2.9	62	88.6	8	11.4	0	0.0	56	80.0	14	20.0	0	0.0	9.44 0.009*	10.05 0.001*	7.45 0.039*
Prevention of incubator's low temperature alarm	24	34.3	44	62.9	2	2.9	60	85.7	10	14.3	0	0.0	59	84.3	11	15.7	0	0.0	16.21 0.0001*	18.99 0.0001*	8.83 0.032*
Causes of sensor alarm of incubator	31	44.3	35	50.0	4	5.7	65	92.9	5	7.1	0	0.0	61	87.1	9	12.9	0	0.0	13.16 0.0019*	17.90 0.0001*	14.10 0.001*

Chi Square Test * Significant at P<0.05 P1. Before &one month after
P2. Before and immediately post P3. immediately post & one month after

Table (4): Percentage Distribution of the Studied Nurses according to their Total Knowledge Scores about Common Alarms Indicators

Total Studied Nurses (n=70)								
Nurses' total knowledge Scores	**Before**		**Immediate**		**One month later**			
	No	**%**	**No**	**%**	**No**	**%**	**Z test**	**P-value**
Low	5	7.1	0	0.0	0	0.0	**Z1**=-7.289	P1= 0.0001*
Moderate	62	88.6	4	5.7	7	10	**Z2**= 7.330	P2=0.0001*
High	3	4.3	66	94.3	63	90	**Z3**= 6.816	P3=0.0001*
Range	22-36		33-42		33-42			
Mean & SD	28.13±2.09		40.38±2.10		38.71±2.16			

Z. Wilcoxon Signed Ranks Test * Significant at P<0.05 P1. Before &one month after
P2. Before and immediately post P3. Immediately post & one month after

Table (5): Percentage Distribution of nurses' practices subitems scores regarding Common Devices Alarms

Total studied nurses (n=70)									
Practice items scores	**Before**		**Immediately post**		**One month after**		**Z_1\ P**	**Z_2\ P**	**Z_3\ P**
	No	**%**	**No**	**%**	**No**	**%**			
Ventilator									
Unsatisfactory	67	95.7	4	5.7	9	12.9	6.430 0.0001*	6.766 0.0001*	2.909 0.004*
Satisfactory	3	4.3	66	94.3	61	87.1			
Range	28-63		28-65		28-64				
Mean & SD	44.97± 4.84		60.14±6.63		58.48±7.68				
Infusion Pump									
Unsatisfactory	68	97.1	3	4.3	4	5.7	7.168 0.0001*	7.198 0.0001*	3.759 0.004*
Satisfactory	2	2.9	67	95.7	66	94.3			
Range	10-34		19-38		12-38				
Mean & SD	23.91± 2.10		35.50± 4.55		34.50±4.26				
Syringe Pump									
Unsatisfactory	68	97.1	3	4.3	3	4.3	7.381 0.0001*	6.559 0.001*	3.794 0.003*
Satisfactory	2	2.9	67	95.7	67	95.7			
Range	12-31		22-37		16-36				
Mean & SD	23.55±1.69		34.51±3.67		33.44±4.04				
Monitor									
Unsatisfactory	66	94.3	4	5.7	6	8.6	6.717 0.0001*	6.919 0.001*	6.777 0.0001*
Satisfactory	4	5.7	66	94.3	64	91.4			
Range	20-39		20-44		20-42				
Mean &SD	26.25± 3.24		41.38±4.69		38.45±5.23				
Incubator									
Unsatisfactory	68	97.1	4	5.7	8	11.4	6.933 0.001*	7.275^{c} 0.0001*	7.235 0.0001*
Satisfactory	2	2.9	66	94.3	62	88.6			
Range	16-30		16-36		16- 34				
Mean &SD	19.10±2.59		33.90±3.92		30.40±3.95				

Z. Wilcoxon Signed Ranks Test * Significant at P<0.05 P1. Before &one month after
P2. Before and immediately post P3. Immediately post & one month after

Table (6): Percentage Distribution of the Studied Nurses according to Total Practices Scores

The Studied Nurses (n=70)								
Total Practices Scores	**Before**		**Immediately post**		**1month after**		**Test & P Value**	
	No	**%**	**No**	**%**	**No**	**%**	**Z**	**P**
Unsatisfactory	66	94.3	3	4.3	7	10	Z_1=8.738	**0.001***
Satisfactory	4	5.7	67	95.7	63	90	Z_2=7.844	**0.001***
Range	122-188		130-218		125-211		Z_3=7.136	**0.001***
Mean& SD	138.24±10.68		205.48±22.20		194.88±26.80			

Z. Wilcoxon Signed Ranks Test * Significant at P<0.05 P1. Before &one month after
P2. Before and immediately post P3. Immediately post & one month after

Table (7): Correlation between Total Nurses' Knowledge Scores and Total Practice Scores

Total Studied nurses (n=70)					
Time		**Total Knowledge Score**		**Total practice score**	
		R	**P**	**r**	**P**
Before	**Total Knowledge score**	----------	---------	0.169	0.162
	Total practice score	0.169	0.162	----------	----------
Immediately Post	**Total knowledge score**	---------	----------	**0.303-**	**0.014****
	Total practice score	0.303	**0.014****		
One Month After	**Total knowledge score**	-------	----------	0.313	**0.008****
	Total practice score	0.313	**0.008****	----------	----------

****. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tail)**

Discussion

Staff members are usually responsible for number of patients, between two and six at one time. The role of a nurse in an NICU is to observe the patients' conditions and engage in a variety of tasks that are necessary to support the patient's recovery. Some of these actions must be performed periodically, while the need for others arises out of (often unpre-dictable) changes in the patient's condition. Alarm systems are intended to alert the nurses about such changes in the

patients' conditions, allowing them to take immediate action when necessary. **(Ding et al., 2023)**

Concerning the studied nurses in the age range, the current results showed that the age of nurses varied from 23-45 years with the Mean ±SD: 31.02± 4.82. Along the same vein, **Sahoo et al. (2023)** found that nearly half of the participant's nurses' age were between 28 and 43 years with an average age of 28.7 years. Similarly, **Rasooly et al. (2021)**, who stated that most of the subjects under study their age was from 20-30 years old. This result was in contrary to **Ali, & Alharbi. (2024),** who stated that low percentage of nurses belonged to the age ranges from 20 to 25 years.

In relation to nurses' gender, the present results showed that most of nurses were females. **Rasooly et al. (2019)**, found that nearly two thirds of the samples were females. On the same line, **Abdelhalim, Mohammed, & Abdelatief. (2019),** who found that more than two thirds of the sample were females.

Regarding to educational level of the studied nurses, the current results found that half of nurses had technical nursing and less than half of nurses had bachelor's nursing certificate. This result might be attributed to most nurses in the past were satisfied with the nursing institute and did not join the college. In addition to lower socioeconomic status and early marriage which prevent them from continuing their higher education.

On the same context, a study conducted by **Bourji et al. (2020)** reported that more than half of the nurses had technical institute. But, this result was in difference with **Deschamps & Sanderson (2021)**, who revealed that a bachelor's degree was held by over two-thirds of nurses. of nursing. Also, **Elbilgahy, Wady, & Badawy. (2023)**, who discovered that more than fifty percent of the studied nurses had bachelor degree of nursing.

In relation to nurses' experience, the present study revealed that more than one thirds of the studied nurses had experience from 5 < 10 years. These results were in agreement with **Bi et al. (2020)**, who declared that less than two thirds of the studied participants their working years ranged from 6-10 years. On the opposite side**, Elbilgahy et al. (2023)**, who found that nurse's experiences were less than 5 years of experience.

The present study illustrated that all of participants didn't attend any workshops regarding common devices alarms. This might be due to nurses' administrators didn't pay attention to alarms management practice due to increased workload this could be because unawareness of NICU administrators regarding the severe hazards and complication associated with alarms ignorance and increased work load inside NICU .Similarly, **Singh et al. (2020),** who stated that over two-thirds of nurses didn't obtain training courses. **Elbilgahy et al. (2023)** vast majority of nurses didn't have any previous training about alarms of pediatric critical units.

In relation to nurses, understanding about types of ventilator alarms, it was evident that less than two thirds of nurses answered this item incompletely in pretest, while, the majority of them answered correctly and completely immediately during post test and after one month of educational instruction. Incomplete knowledge pretest could be could be attributed to half of nurses had technical nursing, poor training programs and absence of standard policies regarding device alarms at NICU. All of these factors lower the nurses' awareness regarding ventilator alarms pre educational instruction. While, their knowledge increases after educational sessions result from the content of teaching sessions was establishes based on nurses, needs and updated evidence based practice, its clarity and the use of different audiovisual materials.

This result was similar with the study performed by **Aysha & Ahmed (2019),** who stated that nurses' understanding improved post intervention compared with pre-intervention evaluation. Also, this outcome was in the same context with **Jeong & Kim (2023)**, who demonstrated that over half of the nurses in the study reported good knowledge about ventilator due to obtaining previous training sessions.

According to the recent study, almost two-thirds of nurses had incomplete answers regarding causes of ventilators' high pressure prior the instruction sessions whereas, most of them had complete correct answers following the instructions. This reflected the importance of regular educational programs carried out for nursing staff in neonatal critical settings. This result was in agreement with **Cvach et al. (2020**) **& Scott (2021)**,who stated that the most common causes of ventilator alarms are increased peak inspiratory pressure and breathing frequency as well as low expired mandatory tidal volume was the most commonly identified causes of ventilators alarms. The study also presented that more than half of the sample had incomplete answers regarding knowledge about syringe pump obstruction alarms. While, the majority of nurses had correct complete answers immediately posttest. Similarly, **Harip, Hasan, & Nordin. (2022),** who stated that it is crucial for nurses to control the movement of the syringe's piston to deliver fluids into the intravenous line tubing and avoid functional errors while administering the fluids. On the other side, **Jeong & Kim (2023),** disagreed with the present study, who found that more than half of the studied nurses reported good knowledge about syringe pump alarms due to obtaining previous training sessions.

The study disclosed that the answers of more than half of nurses regarding the causes of infusion pump alarms were incomplete answers in pre educational instructions while more than ninety percent was complete in post educational instructions. This may be due to lack of educational

programs conducted to nurses and institutional supervision prior educational instructions during the educational instruction; the researcher used interesting different teaching methods and tools as PowerPoint presentation, videos and booklets.

This finding agreed with the results of **Hedda, Nesargi, Balla, YN, & PN. (2021)**, who found that the intervention resulted in a notable increase in understanding of the studied nurses concerning neonatal alarms as infusion pump. In addition, this result was in harmony with **Nyarko, Nie, Yin, Chai, & Yue. (2023),** who clarified that educational interventions was effective in increasing knowledge of nurses about infusion pump posttest compared to low level of knowledge pre-test.

The research demonstrated that more than half of the sample had incomplete answers regarding knowledge about management of monitor alarms. This was in agreement with **Varisco et al. (2021)**, who declared that alarm management implementation educational programs can improve neonates' outcomes and reduces the alarm load at NICU environment. Additionally, **Bi et al. (2020),** mentioned that nursing continuous training is fundamental and nurses managers should implement periodic educational workshops to nurses to increase ventilator alarms management.

In relation to nurses' total practice scores regarding infusion and syringe pumps alarms, the present results showed hat most of the studied nurses reported unsatisfactory levels of practice regarding alarms of infusion and syringe pumps pre-educational instructions. While, most of them showed satisfactory practice right away immediately post and one-month after educational instructions.

These results resembled those of a study as reported by **El-sayed, Abdel-sattar, & Mohamed. (2019) ; Schnock et al. (2024),** who revealed that the majority of studied nurses had low level of practice regarding infusion and syringe pumps alarms prior to intervention as opposed to the minority of them in post intervention and the difference was highly statistically significant.

The current results illustrated that the majority of the nurses under study was scored unsatisfactory practice levels regarding monitor and incubator alarms pre-instructions. While, most of them reported satisfactory levels of practice immediately post the educational instructions and one month later. This result was identical to a research published by **Hendy, Al-Sharkawi, Al-Moniem, & Ibrahim. (2020),** who disclosed that the majority of nurses under study practiced incompetently with reference to incubator alarm pre intervention and then improved after the intervention. Additionally, these results were in harmony with **Lee, Kim, & Han. (2020),** who found that the high percent of the participants had low practice scores regarding monitor alarms pre education compared to posttest.

Regarding total practice score regarding device alarms of the nurses being looked into the current study found that most of nurses obtained unsatisfactory practice scores before educational program, while most of nurses achieved satisfactory practice immediately post and a month following the instructional session. This finding may be due to the educational instruction was prepared in a suitable manner that help nurses to improve gap in their knowledge and subsequently improve their level of practice.

This result was approved with a study performed by **Ali & Alharbi (2024)**, who mentioned that nursing practice, problem-solving skills, professional development, patient outcomes, and decision-making chances are all greatly impacted by nursing education.

Similar outcomes were reported by **Elbilgahy et al. (2023)**, reported that the training protocol helps to increase the practice level of nurses and highly statistically significant improved ($p<0.001$) post protocol training.

Based on the correlation between nurses' total knowledge scores and practice scores, the present study demonstrated a negative relationship between total nurses' knowledge and practice a month following the educational instructions. This could be due to nurses' knowledge increased during the immediate time of instruction application. While nurses' practice need adequate time for implementation and several trials to achieve competent practice leading to negative correlation in between.

This outcome is consistent with the research that was conducted by **Phillips, Sowan, Ruppel, & Magness. (2020),** who found showed an extremely substantial statistical relationship existed between total knowledge level of the studied subjects and their level of practice pre-post education program. Also, this finding was supported with **Aysha et al. (2019) & Obeid & Hassan. (2021),** who reported that there were statistically significant positive correlations between total knowledge scores and practice of nurses in relation to clinical alarms.

Conclusions

Based on these results, it can be concluded that Nurses' performance regarding common alarms indicators at neonatal intensive care unit had improved after implementation of educational Instructions.

Recommendations

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

-Identify gaps in knowledge and competencies needed for practitioners, professional caregivers responsible for responding to devices alarms.

-In service training programs at Neonatal Intensive Care Units should be conducted periodically and regularly to update nurses' knowledge and practices regarding common alarms indicators.

-Appropriate work policies and procedures for alarms management in

every Neonatal Intensive Care Unit should be available.

-Regular devices maintenance to ensure effective alarm function.

-Further research: Replication of the research on a more substantial probability sample to achieve more generalization

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