Nurses' Awareness toward Ventilators' Alarms in Critical Care Units

Rehab Sayed Abd Elsater[1], Mervat Anwer Abd Elazeez[2] & Mohamed fathy mostafa[3]
[1] Demonstrator of Critical Care & Emergency Nursing, Faculty of Nursing, Assiut University, Egypt.
[2] Professor of Critical Care & Emergency Nursing, Faculty of Nursing, Assiut University, Egypt.
[3] Assistant Professor of Anasthesia Intensive Care and Pain Management, Faculty of Nursing, Assiut University, Egypt

Abstract

Background: Alarms play a crucial role in mechanical ventilation as they provide vital life-supporting function. These alarms notify healthcare providers of technical issues or patient-related events that require immediate attention or action**. Aim:** This study aimed to assess nurses' Awareness of Ventilator's Alarms in Critical Care Units. **Research design:** A descriptive research design was utilized. **Setting:** The study was conducted in the intensive care units at Assiut University Hospital . **Sample:** A convenience sample of **40** nurses working in the intensive care units of Assiut University Hospital was included. **Tools:** Data were collected using: **Tool(1) :** An interview questionnaire to assess nurse' demographic characteristics; **Tool(2):** An evaluation of nurses' awareness regarding ventilator alarms. **Result:** Among the 40 nurses who participated in the study, majority were females, More than half had poor knowledge regarding mechanical ventilator (MV) alarms. **Conclusion:** The study showed that a large percentage of nursing staff members need educational and training courses regarding mechanical ventilators alarms. **Recommendation:** The study recommends a follow-up period in future research to accurately assess long-term outcomes.

Keywords: Critical Care Units, Nurses Awareness &Ventilators' alarms.

Introduction:

According to **Cosper et al.(2017) ,**the joint commission on Accreditation of Health care Organizations defines a clinical alarm as "any alarm that is intended to protect the individual receiving care or alert the staff that the individual is at increased risk and needs immediate assistance." Since clinical alarms are regarded as a vital and life-saving key tool, the value of technology is allied with human competence.

Enhanced by custom alarm thresholds for each patient based on prior monitoring data ,alarm logs, and the medical information kept in the patient data management system (PDMS) **(Huske-Kraus et al., 2018)**.

Critically sick patients might get intense care and centralized monitoring in the intensive care unit .In order to help medical personnel make clinical judgments and provide patients with safe treatment and nursing, ventilators, physiological monitors, and infusion pumps are often utilized medical devices. Medical gadgets with alarm capabilities and clinical alerts are common due to the quick growth of critical care medicine **(Hayhurst,2020)** and (Ismael et al., 2023)**.** Clinical alarms are warning signals that are sent out when a patient's condition is or may be worsening and staff members need to be informed so they may take appropriate action **(Sendelbach & Funk, 2013).**

To guarantee patient safety, effective teamwork is necessary for alarm handling ,which goes beyond individual endeavor. According to **Anderson et al., (2023).**, team morning lowers medical errors, and medical team collaboration improves alert handling efficiency. This emphasizes how important teamwork is in the intensive care unit(ICU),as it is crucial for life preservation monitoring and improving the effectiveness of alarm management **Anderson et al., (2023).**

Significance of study

Mechanical ventilator alarms are essential safety mechanisms designed to alert healthcare providers to potentially life-threatening changes in a patient's respiratory status. In critical care units, nurses are often the first responders to these alarms. Therefore, their awareness, interpretation, and timely response are vital to prevent complications such as hypoxia, ventilator-associated lung injury, or even cardiac arrest.

Despite the importance of these alarms, studies have shown that alarm fatigue, lack of training, and poor differentiation between true and false alarms can lead to delayed or inappropriate responses. This highlights the need for improved nurse education, better alarm management strategies, and the development of alarm systems that are both sensitive and specific.

To assess the nurses' awareness toward ventilator's alarm is a well-recognized patient safety concern in

intensive care settings. decreased nurse responsiveness and slow response times to alarms are the potentially dangerous consequences of alarm. The aim of this study determined the factors that modulate nurse responsiveness to critical patient monitor and ventilator's alarms ICU arms in critical care units.

Aim of study:
The aim of this study was to:
▪ Assess the nurses' awareness toward ventilator's alarms in critical care units.

Research question
Q1: What is the level of nurses' awareness toward ventilator's alarms in critical care?

Patients and Method
Study design
A descriptive research design was utilized to carry out this study. Is often used to describe and explore human behaviors. Descriptive research might use a variety of data collection methods, with the most common being questionnaires and interviews. It was a useful approach in research that had clear benefits in helping to describe and explore variables and constructs of interest (**Jain, 2021**).

Setting
This study was conducted in the Trauma Intensive Care Unit, Heart Hospital Intensive Care Unit, Assiut University Hospitals.

Sample:
A Convenience sample of 40 nurses who provide direct care for mechanically ventilated patients was included.

Sampling:
A convenience sampling technique was utilized in this study due to the practical constraints associated with conducting research in critical care environments. The selected sample of 40 nurses was based on their accessibility, availability during the data collection period, and their role in providing direct care to mechanically ventilated patients. This method was chosen to ensure timely data collection and to accommodate the demanding schedules of nurses in intensive care settings. Although convenience sampling does not offer the representativeness of probability sampling,

Inclusion criteria:
▪ Nurses with at least one year of experience in an ICU setting.
▪ Nurses with regular exposure to and direct involvement in managing patients on ventilators.

Exclusion criteria:
▪ Newly recruited nurses, nurses with less than one year of experience.
▪ Nurses working outside critical care areas, such as general medical wards, outpatient clinics, or administrative roles.

Tools for data collections:
Two tools were developed by the researcher based on reviewing related literature and were written in simple Arabic language to suit nurses' level of education.

Tool I: Demographic characteristics of nurses, which consisted of (7) closed -ended questions (gender, age, marital status, level of education, years of experience.

Tool II: Nurses awareness assessment tool regarding mechanical ventilator alarms This tool consisted of 31 questions, which included 26 multiple-choice questions (MCQ) and 5 true/false questions to assess nurses' awareness regarding mechanical ventilator alarms in ICU (nurses knowledge about MV alarms, causes of MV alarms, types of MV alarms) (**Ameen et al., 2022**).

Scoring system;
The score of sentences was included: = correct answers and 0 = in correct answers. A score less than 85% was negative awareness, and a score equal or more than 85% was considered positive awareness.

Method:
This study was conducted in two main phases: preparatory and field work.

Preparatory phase:
Tools development and permission:
▪ Official permission was obtained to carry out the present study, enabling the researcher to initiate data collection**.**
▪ Tools for collecting data were developed by the researcher based on reviewing the current, past, local, and international related literature in various aspects using books, articles, journals, magazines, and references.

Face validity and reliability
Face validity were done by five experts of critical care nursing and medical staff at Assiut University. All corrections and constructive critique were done by the experts and were taken into consideration in the preparation of the final version of the tool.
Reliability of the tools was measured by Cronbach's alpha ,which was 0.824 for tool 2.

Pilot study :
A pilot study was conducted on 10 % of the study subjects over one month in the selected setting to test the tools' applicability and clarity. The data from the pilot study were analyzed; no changes were made to the tools used, so the 10% of subjects chosen for the pilot study were excluded in the study.

Ethical consideration
▪ The research proposal was approved by Ethical Committee in the Faculty of Nursing (approval number 1120230737).
▪ There was no risk for studied nurses during application of the research.

- The study followed common ethical principles in clinical research
- Written consent was obtained from the patients or guidance that is willing to participate in the study after explaining the nature and purpose of the study .
- Confidentiality and anonymity were assured .
- Study patient privacy was considered during the collection of data.

Assessment phase:
Fieldwork phase
- This study was carried out through a period of six months, from the beginning of July 2024 to the end of December 2024.
- The researcher went to the hospital three days per week from 8 am to 12pm to collect data from the studied nurse.

- The researcher greeted the nurse, introduced herself, and the purpose of the study was explained to the studied nurse prior to data collection.
- Assessing socio-demographic characteristics of studied nurses was done by the researcher by using tool one .
- Assessing awareness of studied nurse regarding mechanical ventilators alarms was done by the researcher using tool two.

Statistical analysis:
Data entry and data analysis were done by using the SPSS program (Statistical Package for Social Science) version 26. Data presented as numbers, percentages, Chi- square tests, and correlation regression analysis was utilized. A p-value is considered statistically significant when $p < 0.05$.

Results

Table (1): Percentage distribution of demographic data among studied nurses (n=40)

Gender	N	%
Male	4	10.0
Female	36	90.0
Age		
18-30	34	85.0
>30-40	6	15.0
Marital		
Single	22	55.0
Married	18	45.0
Level of education		
Nursing secondary school diploma	1	2.5
Technical nursing institute	11	27.5
Bachelor degree in school	28	70.0
Years of experience		
1- <5	29	72.5
5-<15	9	22.5
>15	2	5.0

Table (2): Total mean ±SD score of nurses' awareness toward ventilators' alarms (n=40)

	Max Score	Mean ±SD	Range	Mean%
Nurses knowledge about MV alarms	6	4.7±1.09	2-6	78.33
Causes of MV alarms	12	9.58±2.44	2-12	79.79
Types of MV alarms	13	9.03±1.86	6-11	69.42
Total	**31**	**23.3±4.64**	**13-29**	**75.16**

Table(3): Percent distribution of nurses' awareness toward ventilators' alarms (n=40)

Nurses' awareness toward ventilators' alarms in critical care units	Max Score	No	%
Negative awareness	<85%	26	65.0
Positive awareness	≥85%	14	35.0
Mean±SD(range)	**31**	**23.3±4.64 (13-29)**	

Table(4): Relationship between level of nurse's awareness toward ventilators' alarms and their demographic data (n=40)

	Nurses' awareness toward ventilators' alarms in critical care units					
	Negative awareness (n=26)		Positive awareness (n=14)		X2	P. value
	No	%	No	%		
Age						
18-30	25	96.2	9	64.3	7.25	0.007**
>30-40	1	3.8	5	35.7		
Gender						
Male	12	46.2	4	28.6	1.17	0.279
Female	14	53.8	10	71.4		
Marital						
Single	13	50.0	9	64.3	0.75	0.386
Married	13	50.0	5	35.7		
Level of education						
Nursing secondary school diploma	0	0.0	1	7.1	3.45	0.178
Technical nursing institute	9	34.6	2	14.3		
Bachelor degree in school	17	65.4	11	78.6		
Years of experience						
1- <5	21	80.8	8	57.1	2.57	0.277
5-<15	4	15.4	5	35.7		
>15	1	3.8	1	7.1		

Chi square test for qualitative data between the two groups
*=Statistically significant difference (p<0.05)   **=Statistically significant difference (p<0.01)

Table (1): This table shows that males were 10% and females were 90%. 85% of the nurses had an age of ranged between 18-30 years, and 15% were >30-40 year. Singles represented 55% while married nurses 45%. 2.5% had a nursing secondary school diploma, 27.5% were at a technical nursing institute, and 70% had bachelor's degree in nursing. According to years of experience, 72.5% had 1-<5 years, 22.5% had 5-<15 years, and 5% had >15 years. 67.5% training on ICU mechanical ventilator alarm.

Table (2): According to awareness- related knowledge of MV alarms, the max score was 6 with mean ± SD of 4.7 ± 1.09,a range of 2-6,and a mean of 78.33%. According to awareness- related causes of MV alarms ,the max score was 12 with mean ± SD of 9.58 ± 2.44,a range of 2-12,and a mean of 79.79%. According to awareness- related types of MV alarms, the max score was 13 with a mean ± SD of 9.03 ± 1.86,a range of 6-11,and a mean of 69.42%.

According over all nurses' awareness toward ventilators' alarms in critical care units ,the Max Score was 31 with a Mean ± SD of 23.3 ± 4.64, a range of 13-29, and a mean of 75.16% .

Table (3): According to the distribution of nurses' awareness toward ventilators' alarms in critical care units , negative Awareness (<85%) represented 65%, while positive awareness (≥85%) represented 35%;

the mean and standard deviation of the score was 23.3±4.64 with a range of 13-29.

Table (4): There was statistical significant between difference awareness of nurses' awareness toward ventilators' alarms in critical care units and age. While there was no statistical relationship with gender, marital status, level of education, years of experience, and benefits from this training.

Discussion

Mechanical ventilation (MV) has emerged as a life-saving technique in recent years for sustaining patients' breathing and oxygenation while efficiently eliminating carbon dioxide produced by metabolism for an extended length of time **(Ali & Ahmed, 2023).**

A ventilator's parameter alert indicates that the parameter value is higher than its predetermined threshold, which is a crucial signal for medical personnel to get information about patients' aberrant conditions **(Wang et al., 2023).**

The study's sample consisted of forty staff nurses. Gender, age, marital status, educational attainment, and years of experience in critical care units were among the demographic factors. It's also important to note that the majority of Egypt's graduated nursing staff were women, with men making up the minority **(Ministry of Health and Population, 2020).**

As for the gender, Similar to this finding, **Ibrahim et al., (2022)** discovered that women made up the largest percentage of the study sample, with men making up the remaining minority. **Hesham (2016)** also noted that women made up the majority of participants.

In terms of age, the majority of the nurses in the study were between the ages of 18and 30, over two-thirds of them held a bachelor's degree, and less than one-fourth of the sample had five to ten years of experience.

This finding is consistent with a study by **Hesham (2016),** who discovered that over two-thirds of the participants were between the ages of twenty and thirty **(Ibrahim et al., 2022).** They also discovered that over three-quarters of the participants had a bachelor's degree and over two-thirds had received training on ICU mechanical ventilator alarms. Additionally, two-thirds of the participants had attended a training course on how to manage patients on mechanical ventilators.

The study's findings showed that the maximum score for awareness-related knowledge of MV alerts was six, with a mean of 4.7± 1.09, ranging from two to six, and a mean of more than three quarters. According to the study's findings, the maximum score for awareness-related causes of MV alerts was twelve, with a mean of 9.58± 2.44, a range of two to twelve, and a mean of more than three quarters. The study's findings showed that the maximum score for awareness-related MV alert kinds was thirteen, with a mean of 9.03± 1.86, a range of six to eleven, and a mean of more than two thirds.

Presannan et al. (2024) found that while a minority of nurses had strong understanding of ventilator alarm handling, less than half had intermediate knowledge and less than half had poor knowledge. With a range of three to seventy and a mean ± SD of 3.61±11.2, the highest possible score was twenty.

The distribution of nurses' awareness of ventilator alarms in critical care units showed that less than two thirds had negative awareness (<%85) and more than one third had positive awareness (≥%85); the score's mean and standard deviation were 4.64±23.3with a range of thirteen to twenty-nine. More than three-quarters of nurses had inadequate knowledge about mechanical ventilator alarms, while only a small percentage had satisfactory knowledge, according to **Mabrouk Abdelhalim et al. (2019), & (Hassan et al., 2023)** who sought to evaluate nurses' performance regarding device alarms in intensive care units

Contrary to **Mesquita Melo et al. (2014)** ,who sought to evaluate the nursing team's care of hospitalized patients receiving MV in the intensive care unit, the majority consistently monitored the alarms on their mechanical ventilators.

Age and nurses' knowledge of ventilator alarms in critical care units were significantly correlated. Contrary to **Presannan et al. (2024) ,** they found no meaningful correlation between demographic factors and knowledge score**.**

Conclusion
The study concluded that nearly two third of the nurses had negative awareness toward mechanical ventilator's alarms.

Recommendation:
▪ All nurses working with patients connecting to mechanical ventilators need a specific education program and training to improve awareness toward mechanical ventilator's alarms.
▪ To accurately assess long-term outcomes, studies should have a longer follow-up period with multicenter studies to validate our findings.
▪ The future studies should be conducted using well-designed randomized controlled trials or large, comparative observational studies.
▪ Further studies with larger sample size are needed to confirm the current results.

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