

Original Research Article

The effect of applying alarm fatigue strategies related to nursing performance

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ABSTRACT

Background: Nurses working in an intensive care unit (ICU) are dependent on various medical devices to assist with patient monitoring, care and safety. Alarm fatigue is a consequence of an excessive number of alarms in the practice environment. The goal of this research was to identify the effect of applying alarm fatigue strategies related to nursing performance and to evaluate nurses' perceptions concerning to alarm fatigue in intensive care unit King Abdullah medical city, Makkah.

Methods: The study type was a cross-sectional design. A sample of 85 nurses was obtained using a survey instrument that was created using a structured self-administered questionnaire designed based on literature review.

Results: The most rated mean score for Strategies that reduce the alarm fatigue was education and remaining was optimized technology, electrodes, setup customized alarms, and attitude respectively. When proving hypothesis, the findings demonstrate that there are no statistically significant differences between the nurses' alarm fatigue with study variables including gender, age, professional experience and staff position. The use of an evidence-based alarm management strategy can reduce alarm fatigue and ensure the safety of all monitored patients. Therefore, the above strategies on alarm management will be beneficial to reduce the alarm fatigue.

Conclusions: This study's findings have several practical implications on reducing alarm fatigue in intensive care unit. Nurses play a significant role on monitoring the patients, which may leads to alarm related fatigue.

Keywords: Alarm fatigue, Nursing performance, Strategies

INTRODUCTION

Nurses working in an intensive care unit (ICU) are dependent on various medical devices to assist with patient monitoring, care and safety.¹ There is an escalation in the number and type of innovative medical devices used in the ICU for patient care.² The alarm systems of these medical devices (invasive and non-invasive) remain important components of the ICU environment as they alert nurses to the changing physiological parameters of the patient. In the health care setting, the intention of an alarm is to alert the care

provider to the need for an action. A clinical alarm may signify a pump or machine dysfunction or a critical life-threatening event. Although alarms are important in the care of patients, the constant barrage of alarm signals can overwhelm the health care provider and thus threaten patient safety. The number of alarm signals per patient per day can reach several thousand, depending on the unit and hospital.³

The psychological pressure caused by frequent exposure to alarm sounds can desensitize nurses to alarm signals, which can in turn lead to negligence of important clinical

alarms. As a result of alarm fatigue, nurses may not only become dilatory in responding to clinical alarms, but they may readjust the alarms and adopt settings that are not safe for patients and practically turn the alarm systems silent or off.^{4,5} Alarm fatigue is a consequence of an excessive number of alarms in the practice environment. Alarm awareness and education of the nursing staff are crucial to the resolution or mitigation of alarm fatigue.⁶⁻⁸

The American Association of Critical-Care Nurses (AACN) published an evidence-based practice alert on recommended nursing practices for alarm management.⁹ Key points of the AACN recommended practices include establishing an inter professional team to address alarms, appropriate skin preparation before daily changes of electrocardiogram (ECG) electrodes, as-needed pulse oximetry sensor changes for respiratory monitoring, monitoring only patients with appropriate clinical indications, customizing alarm parameters, and initial and continuing education.¹⁰

Communication is important in alarm management. Communication among colleagues regarding procedures and patient conditions can aid in monitoring surveillance and alarm management. Certain patient care activities and procedures may produce false alarms or expected nonactionable alarms. For example, ambulation, suctioning secretions, or patient repositioning can create false or nonactionable alarms due to artifact and extra movement. Suspending alarms during these procedures and nursing cares can decrease alarms and provide clinical context to alarms.^{11,12} However, the challenges to applying alarm fatigue strategies related to nursing performance in Saudi Arabia have not been fully investigated; thus, this study was conducted to identify the effect of applying alarm fatigue strategies related to nursing performance in King Abdullah medical city, Makkah

Aim of the study

The aim of the research was to investigate the effect of applying alarm fatigue strategies related to nursing performance in King Abdullah medical city, Makkah. This aim was achieved through the following objectives: i) to evaluate nurses perceptions concerning to alarm fatigue in intensive care unit; ii) to identify magnitude of alarm fatigue in ICU; and iii) to recognize the areas of concern that require further improvement in alarm fatigue in intensive care unit.

METHODS

Research design, setting, and participants

The design of this study was a descriptive cross-sectional design. The study was conducted from April 2022 to August 2022. The population in this study included all

nurses working in intensive care unit in King Abdullah Medical City (KAMC) Makkah, Saudi Arabia.

Sample size

The selection of the sample was using by simple random sampling method. The inclusion criteria included working in KAMC for more than 6 months and those who are willing to participate in the study. The exclusion criteria included those who are not willing to participate in the study.

Tool of data collection

For the purpose of data collection, the survey instrument was designed based on the initial interviews carried out from the experts in the organization, which helped in gaining an in-depth understanding of the situation and the elements at play. Reference was made to a few standardized questionnaires and specific survey questions were developed based on the requirements of the current scenario, which included the most items suitable to identify the alarm fatigue.¹³ The survey questions consist of three parts. The first part of the questionnaire represented socio-demographic characteristics of the participants: gender, age, nationality, educational level, total clinical experience, clinical experience at current department, current position, and training received on alarm monitoring system. The other part represented survey questions related to nurses' alarm fatigue questionnaire and last part was survey on strategies that reduce the alarm fatigue, which included five strategies such as attitude, electrodes, setup customized alarms, optimized technology, and education. The participants answered the questionnaire by Likert scales. Each questions answer was scored from 1-5 and total score calculated from each item of all strategies.

Ethical considerations

IRB approval was obtained from the KAMC research Center letter 2-909 date 03/04/2022. After getting official permission from IRB, the online survey was distributed to the nurses. For ethical consideration, the aim of the study and an information part explaining the study details was included in survey to obtain their cooperation. Participants was not identified on questions. In this way the researcher-maintained anonymity and confidentiality of the participants.

Data collection

The investigator collected the data from the participants by using questionnaire to get the detailed view from participants. The survey distributed to the study sample by online. A data sheet was provided before beginning to answer the questions, which included a description of the Strategies that reduce the Alarm Fatigue. The questionnaire was distributed on 10 April 2022 to 10 May 2022.

Statistical analysis

The obtained data was analysed qualitatively and quantitatively. SPSS 25 model was used to analyse multiple data to identify key trends and statistics from the data. Descriptive statistics used to examine demographic data of the participants, while a t-test was performed to examine possible differences in means between groups. Differential analysis (ANOVA) was employed to test the statistical association between the variability studied.

RESULTS

Table 1 illustrates that the majority of the participants was male 48 (56.5%) and female was 37 (43.5%). In the age group, most of the participants have age between 30-35 years (51.8%), remaining 35-40 years (23.5%), 25-30 years (20%) and more than 40 years (4.7%) respectively.

Table 1: Sociodemographic and general characteristics of the study population (n=85).

Variables	Values n (%)
Gender	
Female	48 (56.5)
Male	37 (43.5)
Age	
25-30 years	17 (20)
30-35 years	44 (51.8)
35-40 years	20 (23.5)
More than 40 years	4 (4.7)
Nationality	
Egyptian	20 (23.5)
Indian	24 (28.2)
Jordan	2 (2.4)
Pakistan	6 (7.1)
Philippines	11 (12.9)
Saudi	21 (24.7)
Other	1 (1.2)
Level of education	
Bachelor's degree	73 (85.9)
Diploma in nursing	4 (4.7)
Master's degree	8 (9.4)
Total clinical experience	
2-6 years	24 (28.2)
6-10 years	17 (20)
10-14 years	32 (37.6)
Above 14 years	12 (14.1)
Clinical experience in the current department	
2-6 years	49 (57.6)
6-10 years	22 (25.9)
10-14 years	11 (12.9)
Above 14 years	3 (3.5)

Most of the participants nationality was Indians (28.2%) remaining Saudi (24.7%), Egyptians (23.5%), Philippines (12.9%), Pakistan (7.1%), Jordan (2.4%) and other

(1.2%) respectively. Majority of the participants (85.9%) have bachelor degree in nursing remaining having master degree (9.4%) and diploma (4.7%) qualifications. In terms of total clinical experience most of the participants have 10-14 years of experience (37.6%) remaining was 2-6 years (28.2%), 6-10 years (20%) and above 14 years (14.1%) respectively. Coming to the years of experience in the current department most of the participants have 2-6 years of experience (57.6%) remaining have 6-10 years (25.9%), 10-14 years (12.9%) and above 14 years (3.5%) respectively.

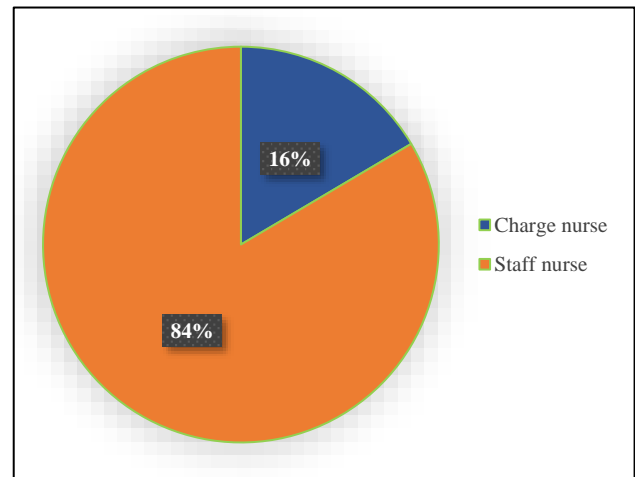


Figure 1: Current position of the participants.

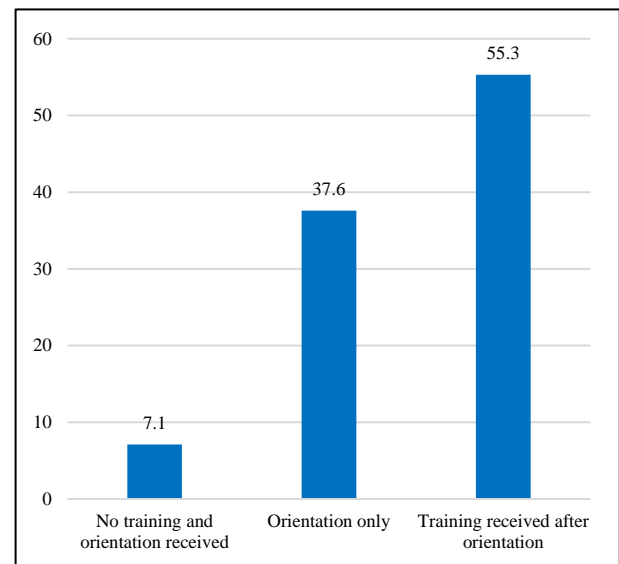


Figure 2: Training received on alarm monitoring system and its functionality.

Figure 1 represents the current position of the staff and most of them were working as staff nurses (84%) and remaining 16% were charge nurses, considering the training received on alarm monitoring system and its functionality 55.3% were received training after orientation and 37.6% received orientation only and only 7.1% not received any training and orientation (Figure 2).

Table 2: Strategies that reduce the alarm fatigue.

Items	Mean±SD
Attitude	
Everyone is responsible for answering all alarms	4.11±1.31
Suspend alarms when performing care activities that create non-actionable alarms	3.21±1.19
Communicate with others to suspend alarms when performing care	3.04±1.30
Alert primary RN if you answer an alarm and complete an intervention	4.05±1.09
Total attitude (mean±SD)	3.60±0.88
Electrodes	
Change ECG electrodes daily or more if needed	4.32±0.91
Place ECG electrodes correctly when alarms from the monitor	3.31±0.63
Is excessive hair should be clipped	4.19±0.90
Skin cleaned and dried with a towel before ECG electrode application	3.36±0.65
Ideal lead placement can reduce alarm	4.20±1.06
Regular checking of the skin under the pulse oximetry sensor can reduce the alarm	4.08±1.01
Change pulse oximetry sensors as needed can reduce alarm	3.96±1.01
When the adhesive wears off, it is time for a new sensor	3.82±1.09
Checking skin integrity under pulse oximetry sensor daily can reduce alarm	4.08±0.91
Total electrodes (mean±SD)	3.92±0.56
Setup customized alarms	
Screening the patient to monitor appropriateness during transfer	4.18±0.84
Discontinue monitoring parameters when no longer needed	3.66±1.10
Examine the patient's rhythm and vital signs to adequately assess alarms	3.48±0.64
Change alarm parameters to reflect changes in patient condition	4.01±1.02
Customize alarm parameters to 10% patient baseline within 1 hour of assuming care	3.61±1.35
Customize alarm parameters to 10% patient baseline when patient condition changed	3.01±1.26
Change status or priority level of particular alarms	3.67±0.95
Total setup customized alarms (mean±SD)	3.66±0.44
Optimized technology	
Use a single sensor for continuous pulse oximetry	3.74±0.97
Identify which alarms are necessary	3.95±1.02
The institution should establish effective clinical policies and regulations on alarm management	4.07±0.89
A central alarm management staff is helpful	4.19±1
Total optimized technology (mean±SD)	3.98±0.76
Education	
Need more education and training on evidence-based monitoring practices	3.96±0.95
Medical equipment's competency helps to reduce alarm fatigue	4.22±0.82
Total education (mean±SD)	4.09±0.79
Total (mean±SD) of strategies that reduce the alarm fatigue	3.82±0.47

Table 2 shows that total mean, SD of all the strategies that reduce the alarm fatigue included 5 strategies such as attitude, electrodes, setup customized alarms, optimized technology, and education. The result shows that the most rated mean score was for education (4.09) and remaining was optimized technology (3.98), electrodes (3.92), setup customized alarms (3.66), and attitude (3.60) respectively. From the result interpretation, it has concluded that education and optimized technology were most strategies that reduce the alarm fatigue in ICU nurses and setup customized alarms and attitude was showing less mean score, which indicate it has least importance in the prevention of alarm fatigue in the hospital from the nurses perspectives.

Table 3: Relationship between nurses' alarm fatigue and gender of the participants.

Gender	Mean	SD	t	Sig.
Male	3.56	0.52	0.446	0.657
Female	3.50	0.68		

Table 3 shows that the mean of the nurses' alarm fatigue for females (3.56), with a standard deviation (0.52), which was higher than the mean of nurses' alarm fatigue for males (3.50) with a standard deviation (0.68) as was the result of the result (T) (0.446) with a probability value (0.657) which was higher than the significance level (0.05). Accordingly, we decide that there were no

statistically significant differences at the significance level (0.05) between the nurses' alarm fatigue of males and females.

Table 4: Relationship between nurses' alarm fatigue and age groups of the participants.

Age groups	Mean	SD	F	Sig.
25-30 years	3.48	0.55	0.90	0.44
30-35 years	3.63	0.71		
35-40 years	3.40	0.33		
More than 40 years	3.35	0.34		

The one-way analysis of variance is shown in Table 4. From it, we conclude that there were no statistically significant differences in the compatibility between age and nurses' alarm fatigue, as the value of (F) was (0.90) with a probability value of (0.44) which was greater than (0.05).

Table 5: Relationship between nurses' alarm fatigue and professional experience of the participants.

Professional experience	Mean	SD	F	Sig.
2-6 years	3.77	0.74	2.15	0.09
6-10 years	3.35	0.57		
10-14 years	3.44	0.46		
Above 14 years	3.57	0.53		

In regards to total clinical experience with nurses' alarm fatigue, there were also no statistically significant differences as the value of (F) was (2.15) with a probability value of (0.09) which was greater than (0.05). (Table 5).

Table 6: Relationship between nurses' alarm fatigue and staff position.

Staff position	Mean	SD	t	Sig.
Charge nurse	3.49	0.69	-0.311	0.756
Staff nurse	3.54	0.58		

The Table 6 also shows the mean of nurses' alarm fatigue for a staff position. Where the staff nurse means was (3.54) with a standard deviation (0.58), which was higher than the mean of nurses' alarm fatigue for charge nurses (3.49) with a standard deviation (0.69) as was the result of the result (T) (-0.311) with a probability value (0.756) which was higher than the significance level (0.05). Accordingly, we decide that there were no statistically significant differences at the significance level (0.05) between the nurses' alarm fatigue of charge nurses and staff nurses.

DISCUSSION

Alarm fatigue is a consequence of an excessive number of alarms in the practice environment. Understanding of the clinical alarms among ICU nurses is vital to guide the

effective management that reduce false alarms and alarm fatigue. Effective alarm management can improve patient safety and the quality of care in hospital settings.^{14,15} Thus, nurses should understand and apply clinical alarm management practices. Therefore, this study aimed to investigate the effect of applying alarm fatigue strategies related to nursing performance in King Abdullah Medical City, Makkah. To attain aim of the study, the findings are discussed into main parts:

Part I: the strategies that reduce the alarm fatigue

The present study identified the effect of applying alarm fatigue strategies related to nursing performance and the result shows that most rated mean score was for education and remaining was optimized technology, electrodes, setup customized alarms, and attitude respectively. From the result interpretation, it has concluded that education and optimized technology are most strategies that reduce the alarm fatigue in ICU nurses and setup customized alarms and attitude is showing less mean score, which indicate it have least importance in the prevention of alarm fatigue obstacle in the hospital from the nurses' perspectives. This is in line with previous studies education on the situation in which alarms of various equipment may occur is required, first, to understand the meaning of the alarms and cope with it.^{16,17} When education and training clarify regarding what should be done and what false alarms are in each alarm situation, nurses are allowed to perform the alarm management activities naturally for patients. In fact, adjusting settings based on patient condition was an effective strategy to minimize alarm volume and to respond in a timely manner. In fact, proper staffing and education were the measures most suggested by nurses to improve alarm perception and response.¹⁸⁻²⁰

Previous studies reported the same thing as the findings in this study; where there was, a decrease in the alarm fatigue by effect of applying alarm fatigue strategies.²¹ The safety alarm protocol implementation effectively reduces the incidence of fatigue alarm among nurses.²² A recent articles supported the concept that an effective alarm management strategy would influence patient safety by ensuring alarms are correct and actionable. In that article, the authors implemented similar strategies based on the AACN alarm management strategy guidelines to reduce alarms.²³ The intervention of the daily electrode change, setup customized alarms, attitude and leadership prioritized alarm management have an impact on reducing alarm fatigue.²⁴

Part II: relationship between nurses' alarm fatigue and variables of the study

When proving hypothesis, the findings demonstrate that there are no statistically significant differences between the nurses' alarm fatigue with study variables including gender, age, professional experience and staff position. The findings agreed with other study that nurses with

different years of nursing work had no statistical significance in their commonly used monitors' alarm response fatigue and also no job position recognize relation with alarm fatigue and female nurses, charge nurses, and nurses who work less than 40 h per week were more likely have a relationship with alarm fatigue.²⁵ Another study result also shows that high-level positions, long working years, high professional titles, and high education are negatively correlated with alarm fatigue.²⁶

Notwithstanding the interesting results, this research has some limitations. The first limitation of this study was that the perceptions of all critical care nurses were not included as they also adopting alarm monitoring in the nursing performance. So, the result cannot be represented as a completely organizational level. Although the strategies proposed in this study covers all the factors previously identified, other dimensions and categorizations could have been proposed to analyse. The study relies on self-reported online survey and if using participant's direct interview may will get more ideas and recommendation to identify areas of concern that require further improvement in terms of alarm fatigue on nursing performance.

CONCLUSION

The main research in this paper was based on the analysis of the current situation and effect of applying alarm fatigue strategies related to nursing performance in the intensive care. The most rated mean score was for education and remaining was optimized technology, electrodes, setup customized alarms, and attitude respectively. When proving hypothesis, the findings demonstrate that there are no statistically significant differences between the nurses' alarm fatigue with study variables including gender, age, professional experience and staff position. The use of an evidence-based alarm management strategy can reduce alarm fatigue and ensure the safety of all monitored patients. Therefore, the above strategies on alarm management will be beneficial to reduce the alarm fatigue.

Recommendations

This study's findings have several practical implications on reducing alarm fatigue in intensive care unit. Nurses plays a significant role on monitoring the patients, which may lead to alarm related fatigue. This study finding will help the healthcare leaders to implement new interventions in the health care organizations to reduce alarm fatigues among ICU nurses. The result of the study showing the strongest and weakest factors that influence strategies that reduce the alarm fatigue related to nursing performance that will help the leaders to prepare improvement programs. This research recommending the health care leaders to evaluate area of concerns for improvement to in use of nursing performance in health settings.

Healthcare organizations should focus on the need of assessing employee concerns on their clinical performance as that will provide basic understanding of the perceptions of their staff. This assessment tools can help healthcare organizations in identifying the areas for improvement. However, further studies are required to include all the nurses working in critical care areas and to identify their perception on factors influence alarm fatigue strategies related to nursing performance. This study strongly recommending for further research on the effectiveness of the strategies that reduce the alarm fatigue among nurses.

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