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Original Research Paper

Alarm weariness among nurses and its connection to noise sensitivity in critical care units

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Abstract
Intensive care unit (ICU) noise has been a longstanding issue, but noise levels exceeding the recommended range impact patients and staff. Nurses who experience alarm fatigue endanger patient safety because it can cause death due to ignoring emergency alarms. This study aims to determine between alarm fatigue and noise sensitivity nurses in critical care units. This study's design was a quantitative study with a cross-sectional with the method of total sampling. The alarm fatigues section was used to gather the data, The instrument developed by Torabizadeh et al. consists of 19 substances, with noise sensitivity assessed through an adaptation within Weinstein's noise sensitivity scale (WNS). Univariate analysis uses descriptive analysis, and bivariate analysis uses Spearman correlation. The exam revealed a strong correlation between noise sensitivity and nurses' alarm fatigue (p-value = 0.000; p-value <α; α = 0.05). Furthermore, the findings of this study also revealed correlation coefficient value of 0.780. Subjective evaluations suggest that increased noise levels in ICUs cause irritation, potentially leading to higher stress, decreased well-being, and lower performance. However, empirical data with objective and physiological measures are needed.

Keywords: alarm fatigue; intensive treatment; noise sensitivity

1. Introduction

Alarm fatigue represents a critical challenge in healthcare environments, especially within high-risk areas such as intensive care units (ICUs). Research has shown that excessive alarms, including false and nonactionable ones, contribute to this problem (Nyarko et al., 2024; Schondelmeyer et al., 2018). High noise levels and recurrent alarms in intensive care units lead to alarm fatigue among healthcare professionals, especially nurses. Research indicates that intensive care units (ICUs) exhibit elevated noise levels, averaging 56.42 dB(A), with acute spikes reaching 80 dB(A) (Kooshanfar et al., 2022). This constant exposure to noise, combined with an average of 45.5 clinical alarms per hour per patient, of the total, 63.8% are false alarms, resulting in alarm fatigue and stress among ICU staff, especially nurses (Salameh et al., 2024; Storm & Chen, 2021). The conventional wisdom that "louder is better" for alarms has been challenged by recent studies, which suggest that alarm levels routinely exceeding ambient noise levels may not be necessary or beneficial (Schlesinger et al., 2018). Additionally, reports indicate that noise levels in hospitals have increased over the decades and significantly exceed the guideline values set by the World Health Organization (Shaban Aysha & Sayed Ahmed, 2019; Witek et al., 2025). In conclusion, the relationship between background noise levels and alarm fatigue is complex. Simply making alarms louder may not be the solution.

Monitoring devices have significantly aided clinicians in responding promptly to patient needs; however, the prevalence of excessive alarms has turned into a considerable annoyance within hospital settings. Research indicates that between 85% and 99% of these alarms are false or lack clinical relevance (Hravnak et al., 2018). A recent literature review indicated that these nurses encounter alarms

that are both excessively frequent and burdensome, interfering with their concentration on critical duties and resulting in attentional lapses, oversight, and mistakes (Lewandowska et al., 2020). Furthermore, prolonged exposure the trust in alarm systems may be diminished by exposure to clinical alarms, adversely affecting both nursing staff and patients (Lewandowska et al., 2020; Nyarko et al., 2024). There's been alarm fatigue recognized as a major factor in alarm-related fatalities in critical care environments (Bach et al., 2018). Alarm hazards were ranked the most critical among ten types of medical device risks in the United States in 2012 (Nguyen et al., 2019).

The factors contributing to alarm fatigue are multifaceted and intricate. Hravnak et al., (2018) have delineated five categories of causes for alarm fatigue, which encompass patient characteristics (including age, diagnosis, and mental status), attributes of monitoring systems (including auditory tones, the pitch, and low specificity); occupational factors such as workload, multitasking, and professional life events, and organizational factors (including the unit's setting, configuration, operational flow, and security atmosphere). Notably, the last two categories present the greatest potential for modification. Claudio et al., (2021) established a system to assess alert fatigue indicators among critical care staff, identifying two principal groups of impacting factors: occupational elements (including job priority, nurse-to-patient ratios, and shift durations) and individual traits (including traits like openness, conscientiousness, and neuroticism). Furthermore, the psychological well-being of nurses, particularly concerning anxiety and stress, has been shown to contribute to alarm fatigue significantly.

Recent studies indicate a correlation connects alarm tiredness and burnout in intensive care nurses (Lewandowska et al., 2020). Burnout is characterised by physical, emotional, and mental exhaustion resulting from demanding work and continuous exposure to high-stress situations (Storm & Chen, 2021). Critical care nurses experiencing Increased levels of alarm fatigue significantly heighten the likelihood of burnout, which in turn degrades the quality of care provided and introduces further concerns to patient safety. To elevate service quality and optimize patient outcomes in critical care environments, it is imperative to understand the magnitude and causative factors of alarm fatigue, along with its effects on nurses, especially in relation to burnout. Prior research investigating noise levels and alarm fatigue among critical care nurses has primarily occurred in the United States, the EU, and the Asian continent. Currently, research on noise levels with alarm fatigue in nurses in Indonesia is still minimal, as proven by studies Giano Tani et al., (2022) which was carried out on fishermen in Manado, showed a correlation between noise and job tiredness levels with a positive relationship, where the louder it is, the greater the effect on work fatigue levels (r count 0.582) and (P-value 0.000).

Several studies conducted in Indonesia focus more on noise in patients. The study Bariana et al., (2024) showed that 60.4% felt noisy, 64.6% felt uncomfortable and 82.8% felt noisy and uncomfortable, the outcomes of the chi-square analysis ($p = 0.002$ is smaller than 0.05), meaning that a correlation exists between noise tolerance and patient comfort in the High Care Unit (HCU) room, meaning that there is noise in the HCU room that makes patients feel uncomfortable. The study Istanti & Fatwati Fitriana, (2024) presented a correlation coefficient of 0.560 and a p-value of 0.010 (p 0.05) between noise exposure and sleep quality. Conversely, the correlation coefficient of 0.471 indicates a significant relationship between sleep quality and room temperature, with a p-value of 0.036. Conversely, air humidity and sleep quality exhibit a p value of 0.001 and a correlation coefficient of 0.560. Comprehensive data on noise levels and alarm fatigue among critical care nurses in Indonesia is insufficient. Therefore, it is essential to examine alarm fatigue and its impact on critical care nurses in Indonesia. Investigating nurse performance issues, including noise levels and alarm fatigue, is crucial as they pertain to enhancing patient safety. This study seeks to ascertain the relationship between noise sensitivity and alarm fatigue.

2. Research Methods

A cross-sectional approach is employed in this observational analytical investigation. The study was performed in the Intensive Care Unit of RSD KRMT Wongsonegoro during July and August 2024. This study employed a complete sampling technique, with 72 respondents who satisfied the inclusion criteria. Inclusion and exclusion criteria: This study encompassed all nurses employed in specific intensive care units who had a minimum of six months of experience and consented to partake in the research. This study excluded vacation (educational institutions, annual leave, illness due to maternity leave, illness due to maternity leave, and maternity leave) because it did not exist in data. Researchers used the Indonesian Version of the Nurses' alarm fatigue questionnaire, which has been translated into Indonesian and developed by Torabizadeh et al. with a Cronbach's alpha value of 0.92 and has been tested for validity in previous studies with a significant value of 0.741 ($p < 0.01$). The Nurses' alarm fatigue questionnaire comprises 19 items, with a total score ranging from 19 to 57. Data was gathered by administering questionnaires to participants in the Intensive Care Unit.

The Weinstein Noise Sensitivity Scale (WNS) has six questions to assess noise sensitivity. We translated the English version into Indonesian. The score for each item was calculated on the Guttman scale. The Weinstein noise sensitivity scale has six items. The assessment was obtained by adding up the total value and then converting it into a percentage (Habiby, 2017), for example, ranging from a minimum of 0% to a maximum of 100%. The researcher clarified the study's objective and methodology, and the responder provided informed consent. Subsequently, researchers commenced interviews based on the inquiries regarding Nurses' alarm tiredness and WNS. Univariate analysis employing descriptive statistics delineates the characteristics of respondents (age, tenure, gender, education) and the research variable. Bivariate analysis employing the Spearman Correlation test was utilized to ascertain the association between noise level and nurse fatigue alarm. This research has received ethical approval under the number 058/Kom.EtikRSWN/VI/2024 from RSD K.R.M.T Wongsonegoro Kota Semarang.

3. Results and Discussion

3.1.Result

3.1.1.Attributes of Participants

Table 1. Frequency Distribution of General Characteristic of Nurse (n=72)

Variable	f	(%)	Min.	Max.	Mean	SD
Age			25	47	32.77	5.09
25-33	46	63.9				
34-47	26	36.1				
Length of Work			1	20	6.98	4.56
1-6 years	33	55				
7-13 years	20	33.3				
14-20 years	7	11.7				
Masculinity						
Male	33	45.8				
Female	39	54.2				
Education						
Diploma III	37	51.4				
Ners	35	48.6				

Source: Primary data, 2024

The results indicated that the majority of respondents were female, including 39 individuals (54.2%), and that 37 respondents (51.4%) had attained a DIII level of schooling. The mean age of respondents was 32.77 years, categorized as a productive age, with the minimum age at 25 years and the maximum at 47 years. Respondents had an average tenure of 6.98 years, with a minimum of 1 year and a maximum of 20 years of employment.

Table 2. Frequency Distribution of Variable Noise level and Alarm fatigue (n=72)

Variable	f	(%)	Min.	Max.	Mean	SD
Noise Sensitivity			16.67	93.33	58.10	21.01
Alarm Fatigue			6.00	87.00	27.80	11.86

Source: Primary Data, 2024

The overall mean score of alarm fatigue among nurses was 58.10± 21.01. The average noise sensitivity is 58.10, with the lowest noise level being 16.67 and the highest being 93.33. Meanwhile, seen from the nurse's fatigue alarm is 27.80, with the lowest fatigue alarm at 6.00 and the highest at 87.00.

Table 3. Mean of Individual item and overall alarm fatigue scale (AFS) score

Alarm fatigue		Mean± SD (27.81±11.87)			
Individual item					
No.	Item	Min	Max	Mean	SD
1.	I routinely modify the alarm thresholds according to patients' clinical symptoms.	0	3	2.04	0.89
2.	I deactivate the alarms at the commencement of each shift.	0	3	0.71	0.93
3.	Typically, I perceive a considerable level of noise in the ward.	0	3	1.67	0.99
4.	I suspect that some of the noise on the ward originates from the alarms of the monitoring devices.	0	3	1.79	1.06
5.	I focus more on the alarms during specific shifts.	0	3	1.83	1.11
6.	Which shift has a ward workload that prevents rapid response to alarms?	0	3	1.78	1.01
7.	As the alarm rang repeatedly, I became increasingly indifferent to the sound of the alarm.	0	2	0.60	0.87
8.	Those alarms make me feel nervous	0	3	0.64	0.84
9.	I exhibit varying responses to the low pressure (yellow) and excessive pressure (red) ventilator alerts.	0	3	1.50	1.03
10.	In states of anger and anxiety, I exhibit heightened responsiveness to the alarm's sound.	0	3	1.08	0.90
11.	When the alarm sounds incessantly, I become exasperated.	0	2	0.71	0.64
12.	The alarm's noise hinders my concentration on personal job responsibilities.	0	3	0.69	0.70
13.	During visiting hours, I neglected to heed the alarms on the equipment.	0	3	0.74	0.84
14.	I regularly modify the warning thresholds according to the patient's clinical manifestations.	0	3	1.33	1.11
15.	I deactivate the alarm at the commencement of each shift.	0	3	0.56	0.95
16.	Usually, I hear various sounds from the ward.	0	3	1.29	1.01

Alarm fatigue		Mean± SD (27.81±11.87)			
Individual item					
No.	**Item**	**Min**	**Max**	**Mean**	**SD**
17.	I am sure that the sounds in the ward are coming from the monitoring equipment alarms.	0	3	1.92	1.13
18.	I pay special attention to alarms on certain shifts.	0	3	1.88	1.22
19.	Which shifts have ward workloads that prevent rapid response to alarms?	0	3	1.50	1.09

Source: Primary data, 2024

According to Table 3 of the alarm fatigue questionnaire, the three highest-rated statements were: I regularly adjust the alarm limit based on the patient's clinical symptoms (2.04 ± 0.89), I believe that the sound in the ward originates from the alarm of the monitoring equipment (1.92 ± 1.13), and I pay particular attention to the alarm during a specific shift (1.88 ± 1.22). The lowest ratings were for the statements: I deactivate the alarm at the commencement of each shift (0.56 ± 0.95), I grow progressively indifferent to the alarm sound due to its repetitive nature (0.60 ± 0.87), and I deactivate the alarm at the commencement of each shift (0.64 ± 0.84).

Table 4. Mean of Individual item and overall Weinstein Noise Sensitivity Scale

Weinstein noise sensitivity scale (WNS) Mean± SD (58.10±21.01)			
Individual item			
No.	Item	Mean	SD
1	I am readily roused by noise.	0.69	0.46
2	I am not bothered by much noise	0.54	0.50
3	I struggle to relax in a noisy environment.	0.61	0.49
4	I can maintain focus regardless of my surroundings.	0.35	0.47
5	I may become irate with others whose noise disrupts my respite.	0.67	0.47
6	I am sensitive to noise.	0.59	0.47

Source: Primary data, 2024

According to Table 4, the three highest individual statements from the Weinstein Noise Sensitivity Scale are: I am easily awakened by noise (0.69 ± 0.46), I can become irate at individuals who create noise that disrupts my rest (0.67 ± 0.47), and I struggle to relax in a noisy environment (0.61 ± 0.49). The least favorable assertion was my ability to concentrate effectively regardless of surrounding distractions (0.35 ± 0.47).

3.1.2. The Result Test of Relationship Noise Level with Fatigue Alarm

Table 5. Result Test of Relationship Noise Level with Fatigue Alarm

Variable	R	*p-value*
Sensitivity noise with Nurse Fatigue Alarm	0.780	0.000*

Source: Primary data, 2024

The analysis revealed a substantial correlation between sensitivity to noise and nurses' alarm fatigue (p-value = 0.000; p-value <α; α = 0.05). This study yielded a correlation coefficient of 0.780, indicating

a very strong positive link, whereby an increase in noise sensitivity corresponds to an increase in alarm fatigue among nurses.

3.2.Discussion

This study seeks to ascertain the relationship between noise sensitivity and alarm fatigue. This study involved approximately 33 ICU nurses (55%) with an average professional tenure of about 6 years. According to (Lewandowska et al., 2020) noted that nurses who worked individuals in the ICU for fewer than 10 years possessed less information regarding alarm fatigue compared to their more experienced counterparts (Paredath & Al Jarary, 2023). The age of nurses employed in the ICU varied from 25-33 years, around 46 nurses (63.9%) and the gender of the most nurses was women, around 39 nurses (54.2%). Based on the study, it states that age, & gender exhibits no correlation with the response to prevalent monitor alarms utilized by nurses. Furthermore, no job position acknowledges the association between alarm fatigue and female nurses. However, charge nurses and those working fewer than 40 hours per week are more likely to experience a relationship with alarm fatigue (Lewandowska et al., 2020). Nurse-patient ratio and gender were identified as predictors of alarm weariness, with female nurses exhibiting greater susceptibility. This may be ascribed to the increased strain that female ICU nurses endure, exacerbated by the demanding work environment and personal obligations, including domestic tasks, children, and the management of work-life balance (Papazian et al., 2018).

Alarm fatigue is intrinsically linked to patient safety and the mitigation of potentially hazardous events. This study revealed elevated alarm tiredness among ICU nurses. This study found that the average overall score of alarm fatigue among nurses was 58.10 ± 21.01, significantly higher than findings from other studies (Bourji et al., 2020; Regmi et al., 2023) from Lebanon which consistently assessed the average mean score of alarm tiredness among nurses, which was 28.03 ± 12.813, compared to 30.57 ± 7.89 for doctors. This disparity may result from variations in the environment, infrastructure, and care protocols within the ICU. Alarm fatigue is a critical aspect of mental health that significantly impacts the quality of life of healthcare personnel. Over time, weariness can adversely affect employee morale and mental health, leading to cardiovascular issues, melancholy, stress, and even burnout (Regmi et al., 2023). The study's findings indicate that participants scored the claims regarding their heightened attention to alarms during specific shifts and their belief that sounds in the ward originate from the monitoring equipment's alerts. Overall, I perceive a significant level of noise in the ward, which contrasts with a study conducted in Lebanon where the statements “Alarm sounds induce anxiety” and “I believe a substantial portion of the ward's noise originates from monitoring equipment alarms” received the highest scores (Asadi et al., 2022; Bourji et al., 2020). This discrepancy may arise from varying settings and protocols employed in the hospital.

The findings of this study indicated that the average alarm tiredness score among ICU nurses was moderate, aligning with prior research (Asadi et al., 2022). Intensive care Nurses are especially vulnerable to alarm fatigue because of the extensive time they dedicate to patient care and monitoring, necessitating continuous vigilance and prompt reactions to warnings from diverse medical devices (Lewandowska et al., 2020). As a result, healthcare practitioners may experience desensitization to recurrent alarm events. This desensitization may cause important alarms to be missed or responded to slowly, resulting in decreased concentration and physical fatigue (Saeed, 2016; Salameh et al., 2024) thereby compromising patient safety and well-being, potentially leading to adverse outcomes, including patient death.

The investigation revealed a substantial correlation between noise sensitivity and alarm tiredness among nurses (p-value = 0.000; p-value <α; α = 0.05). Furthermore, the findings of this investigation yielded a correlation coefficient of 0.780, indicating a very high association and a positive direction of the relationship, where an increase follows each increase in noise sensitivity in nurses' alarm fatigue of

0.780. Noise sensitivity is influenced by individual experience and perceived stressors. In a healthy physical and psychological state, a person can feel the presence of noise but can still tolerate it, on the other hand, in a state of working in hospital services, especially in the ICU, they can be very sensitive to noise. The research conducted by Pal et al., (2022) Park et al. indicates that individuals with a higher level of noise sensitivity are more likely to interpret noise as a threat or disturbance and respond emotionally in comparison to those with a lower level of noise sensitivity. Individuals with heightened sensitivity to noise exposure will struggle to adapt, resulting in stress-related issues among nurses. Noise sensitivity is considered a mediator of the effects of noise on health.

Alarm fatigue, which is characterized by extreme exhaustion as a result of excessive effort in responding to alarms and negative attitudes in interpersonal relationships with patients with excessive alarms, may be the result of constant exposure to excessive alarms, false alarms, and noise among critical care nurses (Bi et al., 2020). Nevertheless, caution is warranted when evaluating the correlation between alert fatigue and burnout as indicated by cross-sectional studies. This association may be bidirectional; heightened alarm fatigue may result in higher burnout, while elevated burnout may concurrently exacerbate alarm fatigue, necessitating further investigation.

Research indicates that sensitive noise in intensive care units (ICUs) adversely affects healthcare staff, resulting in heightened stress and diminished performance (Pal et al., 2022). This commotion is made worse by alarms, which can cause nurses to become distracted and impede their ability to perform their responsibilities effectively. Consequently, it is essential to mitigate noise-induced stress among critical care nurses to enhance the work environment and patient care (Alkubati et al., 2024). Alarm fatigue among nurses can be mitigated by regulating various alarm sounds, decreasing noise sensitivity for specific circumstances, implementing shared monitoring, ensuring simple access to technological help, providing staff assistance, establishing more humane working hours, and instituting alarm management guidelines. Healthcare facilities should assess nurse alarm rules and processes, potentially incorporating artificial intelligence technologies for enhanced alarm management efficiency. The utilization of diverse medical gadgets in intensive care units results in elevated noise levels and louder alarms, which nurses regard as psychological issues. The sample size is somewhat low, and the findings are confined to the critical care environment of a single institution. Consequently, the results may not reflect the entirety of nurses employed in critical care environments in Central Java.

4. Conclusion

This study seeks to ascertain the relationship between noise sensitivity and alarm fatigue. The investigation revealed a substantial correlation between sensitivity noise and nurses' alarm fatigue (p-value = 0.000; p-value <α; α = 0.05). This study yielded a correlation coefficient of 0.780, indicating a very significant positive link, wherein each increase in noise sensitivity corresponds to an increase in nurses' alarm fatigue by 0.780. The study revealed elevated levels of alarm tiredness among ICU nurses. Given that alarm tiredness directly impacts patient safety, proficient handling of medical device alarms can mitigate alarm fatigue and avert potentially detrimental consequences. Our findings provide important guidance for future intervention programs to reduce ICU nurse alarm fatigue, which can be realised by introducing policies on alarm management in hospitals and improving nurses' psychological health. In particular, more education, training, and support should be provided to nurses with short tenure and working in ICUs to prevent and reduce alarm fatigue. Prospective studies may investigate the correlation between nurse attributes and alarm fatigue in care management through a combination of methodologies.

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