



ASSESSMENT OF ALARM FATIGUE, RESPONSE TIME AND PATIENT SAFETY PERCEPTION AMONG ICU NURSES

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ABSTRACT

Background: Clinical alarm systems used to monitor changes in patients' condition in intensive care units are crucial. But if the alarms are continually false, not actionable and repetitive, this can cause alarm fatigue among ICU Nurses. Ineffective attention to alarms, response times and potentially patient safety can all be impacted by alarm fatigue. Hence, it is important to understand how relying on alarm fatigue, response time, alarm management practices and perception of patient safety are related to improve nurse performance and outcomes.

Objective: The purpose of this study was to determine the awareness of alarm fatigue, reaction time to alarm, alarm management and perception of patient safety among ICU nurses. Differences due to training, working shifts and patient load were also analysed, as well as the relationships and predictive effect between the main study variables.

Methods: A structured questionnaire was used to gather the data, which comprised 204 ICU nurses. For statistical analyses, normality tests were conducted using the Shapiro-Wilk test, reliability test (Cronbach's alpha) and validity test (KMO and Bartlett's test). The data were analysed with the independent-samples t test, one-way ANOVA, Kruskal-Wallis test, chi-square test of independence, Pearson correlation and multiple linear regression. A p -value ≤ 0.05 was used as the cut-off value for statistical significance.

Results: The results of the questionnaire had high reliability and construct validity; all study variables were normally distributed. The trained nurse had a significantly better response time compared to the untrained nurse. The alarm-fatigue scores were statistically significantly different between the different patient-assignment groups and also between the fatigue scores of both work shifts. Also, alarm training was highly correlated with the performance in response time. All scale measures showed statistically significant positive relationships with each other for Alarm Fatigue, Response Time, Patient Safety Perception and Alarm Management Practices. Statistically this model was significant, explaining 54.9% of the variance of this model about the patient safety perception. Alarm Fatigue and Response Time were positive significant predictors for the practices.

Conclusion: Alarm-related training, workload, the state of the shift, and the practices in alarm management have significant effects on nurses' response performance and patient safety perception is stated. In an intensive care unit environment, alarm fatigue may not assist in patient safety measures and may lead to the potential for unnecessary alarms if adequate alarm response, staffing and training are not put in place. The use of the correct alarm, the right training, staffing and

response for the correct alarm and minimising unnecessary alarms is the correct way to prevent alarm fatigue in the intensive care unit to improve patient safety.

Key words: Alarm fatigue, ICUs, Response time, Patient safety perception, Alarm-management practices, Clinical alarms, ICU workload, Nursing workload

Introduction

The use of clinical alarm systems in an intensive care unit is crucial. They are useful because they are able to go about continuous monitoring of the patients' physiology and alert healthcare professionals to a potential life-threatening change. These alarms are activated when a measured value is outside of a set value on bedside equipment such as a cardiac monitor, mechanical ventilator, infusion pump, pulse oximeter, and more. These alerts are designed to help with quick clinical decision-making and interventions to help the most. ICUs now have numerous monitoring devices; however, they have also seen a rise in the frequency of audible alarms, many of which may be either false, for which no action is needed; repeated; or technical alarms. Alarms can cause nurse alarm fatigue if they are continually activated (Syed Waqas Ali Shah, 2025).

Alarm fatigue is a situation that can occur due to exposure to a large number of clinical alarms, causing sensory overload, loss of focus or decreased sensitivity to these alarms. If nurses are constantly seeing unnecessary alerts, it may result in them tuning them out. Nurses may ignore the same alerts if they don't present a life-threatening emergency and they become familiar with them. This can lead to a slower reaction time, alarm silences when unnecessary, missing out on key events and not noticing that an alarm is of higher priority than a lower priority alert. Whereas, in a more intense setting, like the ICU, the people there may be on high-priority medical treatment and constant monitoring and missed response to critical alerts may lead to further deterioration in the patient care environment and consequential adverse effects on patient care (Mostaque Md. Morshedur Hassan, 2025).

Hence, a good performance of the nurses is very important, as well as a quick response time for good alarm management. With prompt and responsive behaviour, the nurse will make the needed assessments, identify the cause of the alarm and respond appropriately. But several factors could affect response time, such as workload, staffing levels, nurse-to-patient ratio, alarm frequency, the patients' condition, nursing experience, nursing shifts, training, and complexity of the patients' conditions. When nurses have more patients with serious illness or have several alarms sounding at the same time, they may not be able to be ready to respond promptly. Having a set of alarm management policies and procedures would allow the nurses to better prioritise alarms and respond (Irum Sherwani Summaiya, 2025).

Patient safety perception refers to nurses' perception of the level of support provided by the clinical environment, the system and the professionals in patient care. The key guardians who will hopefully spot deterioration, and who will take steps to stop adverse events from occurring, will be the members of the team in ICU nursing. These include their perceptions of the reliability of the alarm system, team working, level of staffing, workload, and communication or a safe culture of your institution. Insufficient responses, false alarms and delays can contribute to a loss of confidence in monitoring systems and create unnecessary fears of patient harm. However, with effective and proactive alarm management, appropriate alarm response and a greater sense of security can be achieved (Kaleem Ullah Ihsan, 2026).

Evaluation of alarm fatigue, response time and patient safety perceived by critical care nurses is crucial to the identification of problem areas with current alarm-management systems in operation. Such evaluation can be helpful for healthcare administrators to comprehend what factors are influencing how nurses react to alerts generated by clinical alarms, such as training, workload, work shifts, patient assignment and institutional practice. The results can contribute to the case for policy development, alarm triggers, training of staff, workload management and much more. Therefore, the objective of the study is to find the level of ICU nurses' alarm fatigue, the response time of the nurses for any alarm and patients' safety feelings, and examine the relationship between these

variables. It also aims to analyse if the level of training and characteristics of the workspace significantly influenced nurses' awareness of alarms, the management of the alarms and perceived patient safety awareness (Macedonia,2022).

Literature Review

Clinical alarms are an essential system for patient monitoring in Intensive Care (ICU) Units and warn of a change in the patient, a malfunction in equipment and sometimes life-threatening issues. In an ICU environment, a patient may have multiple of the following monitoring technologies connected to them: cardiac monitoring, mechanical ventilators, infusion pumps, pulse oximeter and invasive pressure monitoring devices. The use of such devices in support of rapid intervention may result in a large volume of alerts- many of which may be clinically unindicative, repetitive, technical and/or false. Therefore, a systematic review on the physiological monitor alarms was implemented to examine the proportion of alarms identified as 'actionable' compared to the proportion of alarm(s) identified as 'no action required' to identify the magnitude of the burden asked of healthcare professionals for the majority of alarms without value for clinical action (Mislim Zendeli, 2023).

Alarm Fatigue occurs when the frequent activation of alarms or multiple alarms causes healthcare workers to be cognitively overwhelmed, desensitised, or less responsive. Writings have recently emerged addressing the problem of alarm fatigue as a multi-factorial occupational and patient safety issue of delayed alarm responses, communication issues, psychological stress and burnout. Some of the contributing factors identified include alarm overload, the environment, personal factors and continual exposure to non-actionable alarm messages. The healthcare staff working in the ICUs are at a greater risk as they are operating in an environment with multiple degrees of technologisation, which means that they have to pay constant attention and prioritise. Alarms and alarm fatigue appear to be not just an isolated problem or a particular institution, as evidenced by higher-than-average alarmedness that has been reported by critical-care nurses (Praveenkumar Periyasamy, 2024).

Frequent (nonactionable) alarms may affect the nurses' confidence in alarm monitoring. When these alarms keep going astray and bastardly, nurses might start to consider them as more upsetting than helpful. The literature search in the intensive care nursing field revealed the perception that patient alarms (alarms) are a hindrance to patient care, too many and too cumbersome. Nurses also reported a lack of trust in the alarm systems due to false and unnecessary alarms. Observational research also shows that nurses don't react each and every time an alarm sounds. The study in the ICUs involved 1781 alarms, which were not answered as

a result by the nurse; under 50 per cent of the alarms were not answered until the nurse silenced them, sent for patient evaluation, or the nurse fixed a technical/towernetting problem. These results show the impact of alert level: number of alarms, clinical significance of the alert and technical reliability of the alert (Praveenkumar Periyasamy¹*,2024).

One of the biggest issues with alarms is that they need to be immediately activated and responded to in a "right" way by a healthcare professional to have a positive impact-response time is a significant concern. Many of the alarms which are not essential for action have been associated with delayed responses to infants by the nurses. Alarm research found that most alarms were either not related to an actual emergency or that as alarm counts increased, so did the time to respond to an alarm if it was related to an actual emergency; therefore, it was thought that time lag may be due to alarm fatigue. On the other hand, a systematic exposure to the summary of past actions demonstrated connections among exposure to high levels of alarm and delayed response by the nurse. Response behaviour might also be influenced by perceived urgency, type of alarm, workload, patient condition, distance from the patient bedside, staffing levels and whether the nurse is engaged in another activity. Given the above, the response time can be interpreted as a reflex of personal decision-making and of the working conditions of the organisation (Likowsky Desir⁴ Hira Aslam¹*, 2024).

Alarms and workload/staffing were cited as one of the common factors cited as important to alarm

fatigue and alarm response. ICU nurses could end up juggling several patients with some devices, medication, documentation and communication, as well as emergency interventions. In these cases, the alarms vie with other clinically important tasks. Based on intensive-care nurses' workload, recent studies have shown that nurse responses and controls to an alarm depend greatly on the situation in which the alarm is activated and the cause of the alarm. Fatigue may also be influenced by the type of shifts, for example, how long they are, and due to the disruption to sleep from night shifts and/or the change in pattern. Literature reflects a combination of environmental, personal and organisational characteristics which can contribute to the reduction of alarm fatigue; a few studies failed to report on any difference in alarm fatigue with respect to hours worked or years of job experience, but in this case it was not due to a single factor (Tariq Rafique Praveenkumar Periyasamy^{1*}, 2024).

This has some serious implications for patient safety. Inappropriate silencing of alarms, lack of attention, and late responses can increase the likelihood of missed action or the alerting of an alarm at an inappropriate time. Alarm fatigue has been associated with an increase in the belief elements with an increased tendency to medical error, according to research. In one study, another group of ICU nurses had fewer medical errors, but more alarm fatigue, when fewer alarms were present, suggesting a possible risk for more medical errors with excessive pop-up alarms. Further evidence indicated that alarm fatigue has a negative influence on nurses' perceptions of safe climate and potentially can impact nurses' levels of stress on the job. Patient safety perception is therefore an important outcome, as nurses' own perception of safety is a reflection of their confidence in the systems within the hospital, team working, levels of staffing, alarm reliability, and being able to effectively counter the risk (PERIYASAMY, 2024).

There is also a body of literature that supports targeted interventions to reduce "alarm fatigue." There are potential benefits of alarm customisation, education, equipment maintenance, using the appropriate electrode placement, daily review of alarm limits and multidisciplinary alarm-management protocols. The Physiological Monitor Customisation Software has reduced and shortened the number of medium priority physiologic alarms. While previous review articles have stated that the evidence is not high quality or consistent, evidence-based educational intervention can increase nurses' knowledge and behaviour. However, more recent research suggests that utilizing alarm-management training that is structured can decrease non-actionable alarms, decrease nurse alarm fatigue, and enhance nurse alarm-management practice. Positive rates have also been seen in the change in behaviour of alarm management with the use of unit-based bundles, as well as a decrease in alarm fatigue (Praveenkumar Periyasamy⁷ Abdullah Tariq^{1*}, 2024).

So far, evidence indicates that the existing evidence on alarm fatigue is a major issue of concern for both nurse and patient safety in the ICU. Individual studies of aspects of alarm fatigue, response time, alarm management exercise and patients' perception of patient safety have been conducted. Few studies have quantified and compared the influences of these factors, and not to overlook providing training, patient assignments, and work shifts as well. These can be evaluated side-by-side for the possible added benefit of understanding the impact of alarm burden on the performance of nursing and the perception of safe nursing care. The purpose of this concept is therefore to try to fill an important research gap and come to a second conclusion about the extent of alarm fatigue, response time and perception of patient safety among ICU nurses and investigate the connection of circumstances. The present study thus seeks to fill the great need for research and to assess the alarm fatigue, response time and perception of patient safety among the nurses in the Intensive Care Unit (ICU) and to explore the possible correlation between such clinically important factors (Samin et al., 2025).

Research Methodology

Research Design

In this study, a quantitative, descriptive, cross-sectional research design was used in assessing the level of fatigue, response time and perception of nurses about patient safety in the critical care units of the hospital. The choice of method was a quantitative approach as this will enable the researcher

to obtain quantitative numerical data which can be used to measure the nurses' experiences and perceptions and to find out what relationship there will be between the key variables of the study. As a cross-sectional design, they collected information from the study subjects at the same time under natural conditions. The design was thought to be suitable for determining the occurrence of alarm fatigue and to see how it was related to nurses' performance in responding and their perception of patient safety (Fernando et al., 2024).

Study Setting and Population

RNs completed the study in the selected hospitals that had intensive care unit (ICU) programs. Based on their job specifications, the target population for the survey consisted of medical, surgical, cardiac intensive care, paediatrics, neonatal intensive care and general intensive care nurses. The reason why the nurses from the intensive care unit (ICU) were chosen is that they always receive a large number of clinical alarms from health-care monitoring equipment, ventilators, infusion pumps, and the like. Different age groups, sexes, levels of licensing and qualifications, work shifts and various professional experience levels of nurses were included to get varying responses (Fernando et al., 2023).

Sample Size and Sampling Technique

A total sample of 204 nurses in the ICUs. Participants were recruited through a non-probability convenience sampling technique during the data-collection period when they were available and willing to be in this study. The full-time equivalents of registered nurses, who had immediate patient care duties and three months or more of experience in the ICU, were qualified. Student nurses, administrative nurses, nurses on extended leave or healthcare workers who do not work in intensive care units were excluded. For descriptive, correlational, comparative and regression studies, the number of samples was considered sufficient (Minhas et al., 2025).

Research Instrument

A questionnaire was created with the purpose of gathering data, which was structured and self-administered. A questionnaire was created that had four main sections and demographic information. Data collected for the individuals included their age, gender, nursing qualification, overall nursing experience, actual work experience in the ICU, category of the ICU which were "critical care" and "nurses IV" (150 to 1250 cases), "registered day shift", registered night shift, number of hours spent on work, the load of patients (from 400 to 600 cases), training on alarm management and patient safety. Other sections measured the factors of alarm fatigue, response speed, patient safety perception and alarm-management practices. The questions were answered on a 5-point Likert scale, which ranged from Strongly Disagree to Strongly Agree. Scores were higher the more positively the respondents performed in the various response measures, indicating higher safety perception and better practices in alarm management (Al-Abbasi et al., 2020).

Validity and Reliability

The questions were peer reviewed by experts in nursing, intensive care, patient safety, and research methodology to find the content and face validity. A pilot study with a small sample of nurses working in the recovery room in the ICU (not included in the final study) was conducted. To assess the reliability of the instruments, Cronbach's alphas were calculated; values of 0.70 or higher were considered acceptable. For the Kaiser-Meyer-Olkin test to calculate the construct validity, Bartlett's Test of Sphericity was also used (Al-Abbasi et al., 2021).

Data Collection Procedure

Data collection was with the permission of the authorities concerned at the hospitals. The eligible nurses were informed about the aim of this research, and the questionnaire was given to them. The questionnaires and completed questionnaires were selected on a free-choice basis; standing questionnaires and completed questionnaires did not include the names and information of

individuals appended to the responses to the questionnaires (Alsamarrai et al., 2019).

Data Analysis

The statistical data were coded and analysed with the help of statistical software. Descriptive statistics (frequency, percentage, mean and standard deviation) were used. The data were subjected to normality, reliability and validity tests. Normality, reliability and validity testing were carried out. The following statistical analyses were conducted: Independent-samples t-test, One-way ANOVA, Kruskal-Wallis test, Chi-square test, Pearson correlation and multiple regression analysis. A p-value less than 0.05 was considered to be a statistically significant (Mahamed, 2019).

Ethical Considerations

Measures were undertaken for informed consent, confidentiality and anonymity and voluntary participation, and to ensure that the participants were able to withdraw their participation whenever they wished. Only for the field of study was this information collected (Nassri & Mahmed, 2023).

Data Analysis

Table 1: Normality Test

Variable	N	Mean	Standard Deviation	Shapiro-Wilk Statistic	p-value	Distribution
Alarm Fatigue	204	44.593	10.090	0.989	0.129	Normal Distribution
Response Time	204	47.353	10.981	0.991	0.290	Normal Distribution
Patient Safety Perception	204	49.593	9.619	0.990	0.243	Normal Distribution
Alarm Management Practices	204	33.074	7.318	0.987	0.057	Normal Distribution

Normality Test

Table 1 shows the normality test of the data. The normality of the compound scores was assessed with the Shapiro-Wilk test. Results showed that the p values for Alarm Fatigue were 0.129, Response Time 0.290, Patient Safety Perception 0.243 and Alarm Management Practices 0.057. The p values for all were above the 0.05 level of significance. Thus, we did not reject the null hypothesis of normal distribution. Constructed upon this, all four composite variables with the use of this scale were determined to be normally distributed. Data were not considered to be normally distributed, and parametric statistical tests were employed, e.g. an Independent samples t-test, one-way ANOVA, Pearson correlation and Multiple linear regression analysis (Mahmedand & Obeed, 2020).

Table 2: Reliability Analysis

Scale	Number of Items	Cronbach's Alpha	Reliability Level
Alarm Fatigue	15	0.929	Excellent Reliability
Response Time	15	0.930	Excellent Reliability
Patient Safety Perception	15	0.926	Excellent Reliability
Alarm Management Practices	10	0.906	Excellent Reliability
Overall Questionnaire	55	0.948	Excellent Reliability

Reliability Analysis

Table 2 shows the reliability analysis of the data. Cronbach's alpha reliability test was used to determine the reliability of the questionnaire. The alpha value for the Alarm Fatigue scale was 0.929, the Response Time scale was 0.930, the Patient Safety Perception scale was 0.926, and the Alarm Management Practices scale was 0.906. All the external construction of the questionnaire had achieved a reliability score of 0.948. All the obtained values were more than 0.7, which is the recommended value, and more than 0.9. However, high internal consistency of the questionnaire

was demonstrated based on that. The results indicate that the content of each scale reliably assessed the same construct. Thus, it can be observed that the research instrument is very reliable to use in assessing the alarm fatigue experienced by intensive care unit nurses, response time, perception of patient safety and alarm management practice (Hadi et al., 2025).

Table 3: Validity Test (KMO and Bartlett's Test)

Validity Measure	Value	Acceptance Criterion	Decision
Kaiser-Meyer-Olkin Measure	0.945	$KMO \geq 0.60$	Valid and Acceptable
Bartlett's Chi-Square	7,842.316	Higher chi-square with $p < 0.05$	Valid and Acceptable
Degrees of Freedom	1,485	Based on 55 questionnaire items	Acceptable
Significance Level	<0.001	$p < 0.05$	Valid
Overall Construct Validity	Excellent	$KMO \geq 0.60$ and Bartlett's $p < 0.05$	Valid and Acceptable

Validity Test

Table 3 shows the validity test of the data. The construct validity of the questionnaire was measured by the Kaiser-Meyer-Olkin measure and Bartlett's Test of Sphericity. The obtained KMO value was determined to be '0.945', which was very high as compared to the minimum requirement '0.60'. The result of this finding was good sampling and was certainly positive for the "satisfaction" results for the items in the presented questionnaire, and factor analysis was conducted. The result of this finding, for the first time, was good sampling and definitely positive for the result of sufficient correlation formed between the items of the questionnaire given to analyse. Logically, Bartlett's Test of Sphericity was statistically significant with a chi-square of 7,842.316, 1,485 degrees of freedom and a p-value less than 0.001. The change was subject to an assumption test that the correlation matrix was an identity matrix, where the significant result rejected that assumption. Therefore, the questionnaire was determined as extremely valid without any disadvantages, and it was determined that it was acceptable and appropriate for it to be used for data analysis (Hadi & Mohamed, 2025).

Table 4: Combined Inferential Statistical Tests

Statistical Test	Variables / Group Comparison	Test Statistic	Degrees of Freedom	P-value	Effect Size	Decision
Independent Samples t-Test	Alarm Training and Response Time	$t=9.557$	165.39	<0.001	Cohen's $d = 1.379$	Significant and Acceptable
One-Way ANOVA	Work Shift and Alarm Fatigue	$F=11.821$	3,200	<0.001	$\eta^2 = 0.151$	Significant and Acceptable
Kruskal-Wallis Test	Patients per Shift and Alarm Fatigue	$H=13.775$	3	0.003	$2 = 0.054$	Significant and Acceptable
Chi-Square Test of Independence	Alarm Training and Response-Time Category	$\chi^2=37.647$	1	<0.001	Cramér's $V = 0.430$	Significant and Acceptable

Independent Samples t-Test

Table 4 shows the Combined Statistical Tests of the data. The scores were compared between the two groups of nurses (ICU and non-ICU) trained on and not trained on the use of the alarm-management system by performing an independent samples t-test. This was found to be statistically significant ($t=9.557, p<0.001$). Thus, the null hypothesis, which states that there is no difference between the two groups, was rejected. Alarms in the nurses' training group (ACTT) showed meaningful improvement overall in comparison to nurses who had not completed the training

regarding their response-time scores. These findings were also statistically significant with a Cohen's d-value of 1.379, which indicated that there was a large effect size-not only did the findings turn out to be statistically significant, but so too was the difference found to be also practically significant. Furthermore, these results point towards the need for structured alarm management training to enhance the capacity of nurses to effectively and quickly deal with clinical alarms in an intensive care unit (Al-Dossary,2026).

One-Way ANOVA

It was decided to use a one-way analysis of variance to see if there is a difference between the scores of the Morning, Evening, Night shift and Rotating shift groups on the alarm fatigue scale. The analysis produced a statistically significant result, $F(3,200)=11821, p<0.001$. As a result, it was determined that the null hypothesis, which stated that all five shift groups had the same mean alarm-fatigue score, was rejected. According to the results, ICU nurses' level of alarm fatigue was significantly different when it comes to their daily working shift. There was a small amount of variance in the alarm-fatigue scores that did not involve any of the components of the work shift, which was revealed by the eta-squared value, a figure of 0.151. This finding is a meaningful effect and indicates that a variety of factors that are related to shift work, such as working conditions, workload, staffing levels and exposure to clinical alarms, could have a potential impact on alarm fatigue among ICU nurses (Kwon & Kim, 2026).

Kruskal-Wallis Test

The alarm fatigue score was compared among the patients according to the number of patients/Nurse/Shift using the Kruskal-Wallis test. Analysis results showed that there was a statistically significant difference, $H=13.775, df=3, p=0.003$. The null hypothesis, which stated that distributions of scores were equal between the patient-assignment groups, was rejected because the p-Value $vW_a < 0.05$. The results of this finding suggest that there is fear fatigue from the level of one group of nurses versus another. The effect size ($\epsilon^2=0.054$) was small to moderate in size. This impact was not found to be as pronounced, but it has clinically relevant implications, as an increased number of patient assignments and increased frequency of the clinical alarm signal will mean that patients have a greater workload, exposure to the clinical alarm, cognitive load, and become desensitised to the frequent clinical alarm (Dong et al., 2026).

Chi-Square Test

To explore the relationship between alarm management training and the various categories of response times, a chi-square test of independence was used. The result was statistically significant, $\chi^2(1)=37.647, p<0.001$. Therefore, the null hypothesis (no association between level of alarm training and level of performance on the task) is rejected. There were 84 low- and 40 high-response-performing nurses who had been trained on alarms. Nurses who had alarm training/High response (84) and low response (40). Considerably fewer (19) nurses-without training-had high response performance compared to 61 who had low response performance. The degree of association between the variables: Cramér's V value was 0.430, which was grouped in the medium to strong group. Results show that response performance in the alarms after the alarm management training was highly correlated with this training and could potentially help to enhance a nurse's ability to respond to alarms in a timely and appropriate manner (Xu et al., 2025).

Table 5: Pearson Correlation Matrix

Variable	Alarm Fatigue	Response Time	Patient Safety Perception	Alarm Management Practices
Alarm Fatigue	1.000 (Self-correlation)	0.505($p<0.001$)	0.637 ($p<0.001$)	0.570($p<0.001$)
Response	0.505($p<0.001$)	1.000 (Self-	0.620 (p	0.726($p<0.001$)

Time		correlation)	<0.001)	
Patient Safety Perception	0.637(p<0.001)	0.620(p<0.001)	1.000 (Self correlation)	- 0.638(p<0.001)
Alarm Management Practices	0.570(p<0.001)	0.726(p<0.001)	0.638 (p<0.001)	1.000 (Self-correlation)

Pearson Correlation Matrix

Table 5 shows the Pearson correlation analysis of the data. Pearson's correlation between the study variables revealed that all were expressed positively and significantly correlated. Response Time, Patient Safety Perception and Alarm Management Practices were all positively correlated with Alarm Fatigue: $r=0.570$; $r=0.637$; $r=0.505$, respectively. Response Time was also predictive of the Patient Safety Perception, $r=0.620$, and Alarm Management Practices, $r=0.726$. The positive correlation between Patient Safety Perception and Alarm Management Practices ($r=0.638$) holds. Every relationship was significant at more significant than $p<0.001$. Response Time was the most significant relationship among the significant ones, Alarm Management Practices. The positive direction relates to an increase in the value of one variable with an increase in the value of the other variable. These correlations, however, should be noted as associations and not as causal relationships (Hohenwallner et al., 2025).

Table 6: Multiple Regression Analysis

Model Component /Predictor	B	Standard Error	Standardized β	t-value	p-value
Constant	9.457	2.376	Not applicable	3.980	<0.001
Alarm Fatigue	0.352	0.056	0.370	6.244	<0.001
Response Time	0.248	0.067	0.260	3.716	<0.001
Alarm Management Practices	0.314	0.096	0.239	3.262	0.001

95% CI Lower	95% CI Upper	R	R ²	Adjusted R ²	F-value	Model p-value	Decision
4.772	14.142	0.741	0.549	0.542	81.197	<0.001	Significant
0.241	0.463	0.741	0.549	0.542	81.197	<0.001	Positive and Significant
0.116	0.379	0.741	0.549	0.542	81.197	<0.001	Positive and Significant
0.124	0.504	0.741	0.549	0.542	81.197	0.001	Positive and Significant

Multiple Regression Analysis

Table 6 shows the regression analysis of the data. Multiple linear regression was performed to see if Alarm Fatigue, Response Time and Alarm Management Practices predicted Patient Safety Perception. The overall model was statistically significant, $F(3,200)=81.197$, $p<0.001$. The model produced an R value of 0.741, an "R" ² value of 0.549, and an adjusted R² value of 0.542. That is, the three predictors accounted for 54.9% of the variance in patient safety perception. Alarm Fatigue was the strongest predictor, with $B=0.352$ and $\beta=0.370$, followed by Response Time with $B=0.248$ and $\beta=0.260$, and Alarm Management Practices with $B=0.314$ and $\beta=0.239$. All the predictors given below were positive and significant. Having a higher score increases the measured predictor, therefore increasing the perception regarding patient safety among nurses working in the ICU (Ajang et al., 2025).

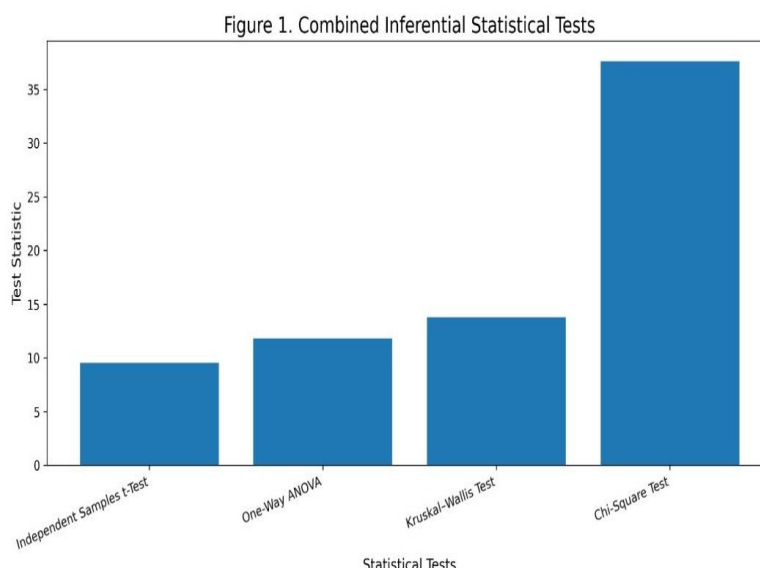


Figure 1: Combined Inferential Statistical Tests

Four inferential statistical tests were used to test the group differences and examine group association between study variables and are presented in Figure 1. Children's overall major score for response time was found to be significantly different with the Independent Samples t test for April Classified Nurses who took the alarm-management training sessions as compared to those who did not. The One-Way ANOVA also showed there to be significant differences between the various work shifts in alarm-fatigue levels. The Kruskal-Wallis test also revealed that differences were significantly related to the different shift schedules with regard to alarm fatigue scores. The chi-square test had the highest chi-square value, and the chi-square test was significant when compared to the response time performance categories of alarm-management training. In general, results of all four inferential tests were found statistically significant (Lewandowska et al., 2020).

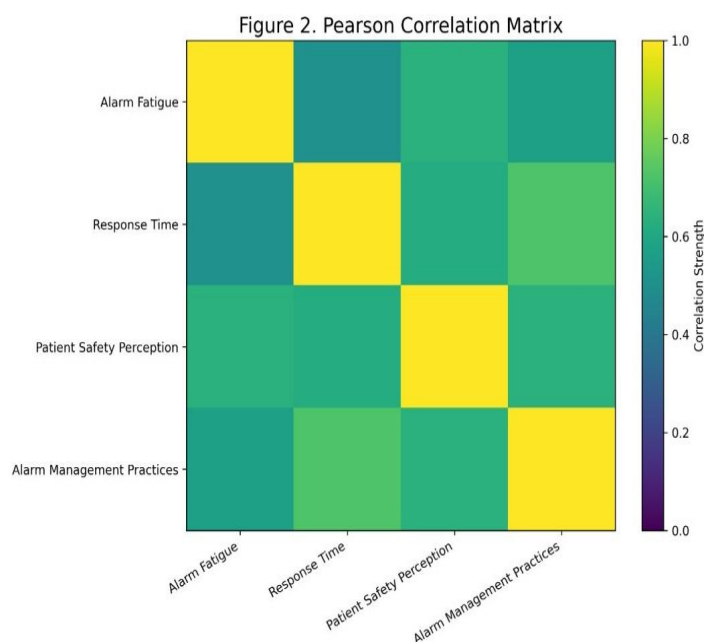


Figure 2: Pearson Correlation Matrix

The strength and/or direction of the relationships between Alarm Fatigue, Response Time, Patient Safety Perception and Alarm Management Practices are shown in Figure 2. All of the correlations were positive; that is, if one variable went up, so did the other variable. The highest correlation was found to be between Response Time and Alarm Management Practices, indicating that high scores

on response time correlated well with high scores on Alarm Management Practices. With respect to chosenness, Alarm Fatigue and Alarm Management Practices were also highly and positively correlated and very similar to each other. All other relationships were moderate to strong with statistical significance. Overall, the correlation matrix validates the meaningful connections between the study variables, but can be interpreted not as cause/effect relationships but as associations (Wang et al., 2023).

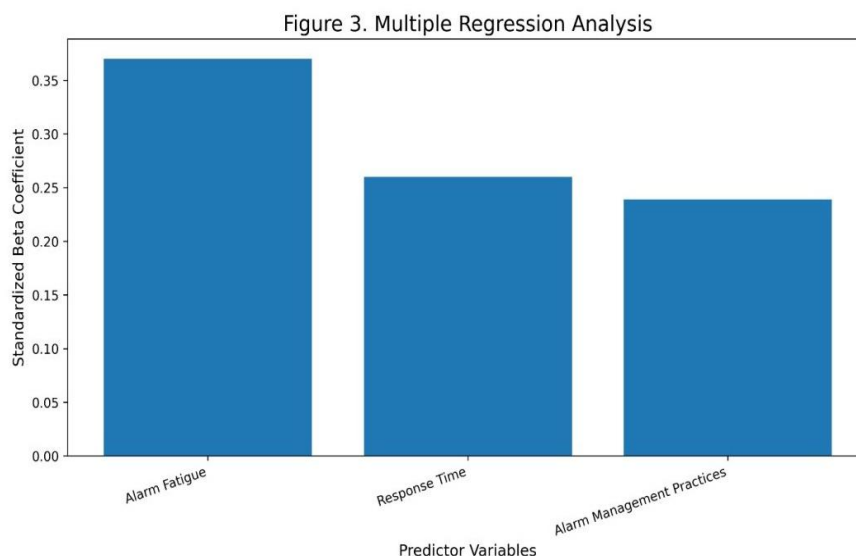


Figure 3: Multiple Regression Analysis

The results of Alarm Fatigue, Response Time, and Alarm Management Practices in predicting Patient Safety Perception are presented in standardized regression coefficients (in norm distribution) for ICU nurses in Figure 3. The three predictors were all expected to be positive because higher scores on these factors would go with higher scores on patient-safety perception scores. Alarm Fatigue had the greatest standardised β -coefficient and thus was the most powerful predictor in the regression analysis. The second best predictor was Response Time, followed by Alarm Management Practices. The regression model was highly significant ($p < 0.001$) with a fair amount of variance explained for Patient Safety Perception. Taken together, this research suggests that alarm-related stressful events, responsiveness, and appropriate alarm use practices have a strong impact on patients' perceptions of patient safety by ICU nurses (Gul et al., 2024).

Discussion

The findings in this study indicated that the correlation between Alarm Fatigue, Response time and the perception of alarm management and patient safety is highly related in intensive care settings. Alarms play an important role in the critical care unit (ICU) to help remind staff when there is a change in a patient's clinical condition, yet too many false or uncorrelated alarms may lead to "alarm fatigue" and/or mental overload for the critical care nurse. For this current data, there seems to be a very important relationship between nurse training, their working shift, nurse workload, alarm management behaviours and the effectiveness of the nurse's response to patient alarms, as well as their overall perception of the safety concerns for their patient. The results support the overall concept that technology alone is not the only factor in this equation of alarm safety; staffing issues, professional competency, the overall organisation of workflow and institutional policies are all significant factors to consider (Carelli et al., 2022).

In the significant independent samples t-test, the performance of nurses related to response time in the ICU with alarm management training was better than the performance of those who were not given training. This difference was of significant magnitude (large effect size). Training can help nurses distinguish between alarms and non-critical data; prioritise a clinical response; and contribute to quicker decisions when faced with uncertainty and/or a high number of alarms. This result reminds us of the need for continued educational efforts highlighting alarm settings, priorities,

alarm escalations, and proper procedure for response. Constant simulation training can also enhance clinical sense and boost nurses' confidence dealing with multiple alarms (Ramlaul et al., 2021).

The results of the one-way ANOVA indicated that there are significant differences between the alarm-fatigue scores for each of the work shifts. Some of these changes might lead to an increased workload, less staffing, increased awareness or more complex patient situations, which may further put a nurse at risk. When working night jobs and rotating across shifts, the demand for continual thinking, little or no support, fatigue and circadian disruption are likely significant issues. If the working conditions are different for each shift, hospital administrators don't need to adopt the same alarm management strategy for all shifts, says Algersblom. Break times and alarm distribution, workload, and supervision arrangements of staff levels need to be adjusted according to the workload and operating requirements of the shift (Bi et al., 2020).

The Kruskal-Wallis results also revealed a significant difference between the number of patients each nurse cared for, concerning alarm fatigue. This can increase workloads, which can result in an increased number of devices that need to be managed; there are more alarms, more clinical workloads, and more competing priorities. With more and more alarms being set, nurses become insensitive or laggy in their response. The effect size was still relatively small, but it could be clinically significant since a small time for responding to alarm conditions can have an impact in critical care (Ceylan & Karakoc, 2023).

The chi-square test showed that there was a significant association between what he/she learned in subjects (alarm management) and their response times. This corroborates the above t-test results and concludes that the trained nurses' response performance is better than that of the untrained nurses. The results also show the following relationships between all the studied variables, which are positive; there is a positive relationship between alarm management practices, response time and perception of patient safety. In terms of relationship with timely clinical action, organised alarm procedures were found to be quite similar, as shown by the strongest relationship with response time, as illustrated by the alarm-management practices (Lu et al., 2024).

Last, a good amount of variance in patients' perceptions of safety was accounted for by the regression model. All of the variables measured characteristic that of alarm fatigue, response time, and alarm-management practices were positively correlated with the criterion. The results in general highlight the importance of providing organised training, the optimum nurse-to-patient ratios, ensuring staffing is carried out during shifts and ensuring that alarm set-up procedures are uniform. All of these can have a positive impact on decreasing alarm fatigue, reacting more efficiently and increasing patient safety within the ICU environment (Alsuyayfi & Alanazi, 2022).

Conclusion

In the current study, they found the following correlation between alarm fatigue, nurse response time to an alarm, how the nurse responds to an alarm, and perception of patient safety in an intensive care unit. The outcomes showed there was better cooperation of the trained nurses in terms of time taken in response than the non-trained group of nurses. In addition to differences by work shift, patient-assignment category differences, with higher alarm-fatigue scores for nurses working on intensive care and coronary care units (CCUs), showed a relationship between workload and shift-related factors on nurses' ability to appropriately manage clinical alarms.

The positive correlations between the primary study factors supported the association between having effective alarm-management practices and responding timely, and the combination of the two leads to high levels of patient-safety perceptions. The other regression analyses also indicated that the three variables-alarm fatigue, response time and alarm management practices-responded to a significant portion of patient perceptions of safety and therefore had meaningful predictive properties. These results indicate the need to take into account the individual and organisation dimensions when evaluating the safety of an improvement to alarms in ICUs.

Hospitals need to keep nurse/patient ratios adequate, review alarm settings to minimise unnecessary alarms or alarms without action, provide regular training on alarm management and create standard alarm-management policies. Workloads and staff scheduling should also be considered on a shift-

by-shift basis, particularly during periods of stress and/or low staffing. Safety improvements such as improved alarm management, improved patient safety education and well-trained nursing staff, and appropriate clinical processes, in general, would help decrease alarm fatigue, improve alarm response, and ultimately improve patient safety in the intensive care unit.

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