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ASSESSING THE PREVALENCE OF ALARM FATIGUE AMONG CRITICAL CARE NURSES: A CROSS-SECTIONAL STUDY

Original Research

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ABSTRACT

Background: Alarm fatigue has become a critical patient-safety concern in intensive care environments where nurses are continuously exposed to high volumes of auditory and visual alarms. Persistent, repetitive, and often non-actionable alarms contribute to desensitization, delayed responses, cognitive overload, and burnout. Critical care nurses, who interact most frequently with monitoring equipment, are particularly vulnerable to this phenomenon. In low- and middle-income countries, including Pakistan, research on alarm fatigue remains limited despite increasing technological dependence within ICUs. Understanding its prevalence is essential for improving safety and clinical performance.

Objective: To assess the prevalence of alarm fatigue among critical care nurses working in a tertiary-care setting.

Methods: A descriptive cross-sectional study was conducted among 123 critical care nurses at Hameed Latif Hospital, Lahore. Participants with at least six months of ICU experience were included through census sampling. Data were collected using a structured questionnaire consisting of demographic variables and a validated alarm fatigue tool scoring from 0–52. Alarm fatigue was categorized as no (0–7), low (8–20), moderate (21–32), or severe (33–52). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used for analysis. Ethical approval and informed consent were obtained before data collection.

Results: Most participants were female (63.4%) and young, with 48.8% aged 22–26 years. The largest proportion (61.0%) had 1–5 years of ICU experience. Alarm fatigue indicators revealed that 47.2% always readjusted alarm limits, 48.8% reacted differently to high- and low-priority alarms, and 41.5% became indifferent when alarms repeated. Additionally, 35.8% reported losing patience with continuous alarms, while 28.5% stated that heavy workload hindered timely alarm response.

Conclusion: The study demonstrated a considerable prevalence of alarm fatigue among critical care nurses, influenced by workload, experience level, and continuous alarm exposure. These findings highlight an urgent need for structured alarm-management training, technological refinement, and supportive strategies to safeguard both nurse well-being and patient safety.

Keywords: Alarm Fatigue, Burnout, Professional, Critical Care Nursing, Fatigue, Patient Safety, Workload, Young Adult.

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INTRODUCTION

Alarm fatigue has emerged as a critical yet often underestimated threat to patient safety in modern intensive care environments. Critical-care nurses, who serve as the primary caregivers for hemodynamically unstable and technologically dependent patients, are continuously exposed to an overwhelming number of auditory and visual alarms generated by monitoring devices, ventilators, and infusion pumps. These alarms are designed to alert staff of physiological instability or equipment malfunction, but the excessive frequency of false, non-actionable, or poorly prioritized alerts can inundate nurses and diminish their attentiveness over time (1,2). As a result, alarm fatigue develops—a condition in which desensitization to alarms reduces the likelihood of timely responses to clinically significant alerts, thereby jeopardizing patient outcomes. Evidence suggests that alarm fatigue is widespread among critical-care nurses globally, and its consequences extend beyond patient harm. Exposure to constant noise, ambiguous alarm tones, and frequent false alarms contributes to sensory overload, emotional exhaustion, and reduced trust in monitoring technologies (3,4). Studies highlight that nurses are especially vulnerable because they interact most closely with alarm-generating devices during routine monitoring and emergency care (5). Research further indicates that both nurses and physicians experience alarm fatigue, though the burden is often heavier on nursing staff due to their continuous bedside presence and responsibility for rapid intervention (6). This burden has become more pronounced as ICUs have grown increasingly dependent on advanced medical technologies. Devices such as ventilators, cardiac monitors, and infusion pumps generate thousands of alarms per patient per day, many of which require no immediate intervention. In such environments, nurses may struggle to distinguish between critical and non-critical alarms, leading to delayed responses, reduced vigilance, and potential patient harm (7). The psychological effects are equally concerning; persistent alarm exposure contributes to burnout, stress, and fatigue, particularly among first-line nurses working in high-acuity or pandemic-driven environments (8). Burnout further increases the risk of inattentiveness, thereby perpetuating a harmful feedback loop between alarm fatigue and suboptimal patient care (9).

Despite growing global awareness, alarm fatigue remains insufficiently understood in many low- and middle-income settings, including Pakistan. Most available literature originates from high-income countries with well-established alarm management protocols. In contrast, healthcare systems in countries like Pakistan face unique challenges, including staffing shortages, limited training on alarm systems, variability in ICU monitoring technology, and inconsistent alarm management policies. Local evidence from private tertiary-care settings is particularly scarce, leaving nursing managers and policymakers without adequate data to guide interventions. International findings demonstrate that targeted alarm management programs, staff training, and technological improvements can significantly reduce alarm fatigue, yet such initiatives are rarely documented or evaluated in Pakistan (10-12). This gap highlights the urgent need for context-specific research that examines how alarm fatigue manifests among Pakistani critical-care nurses and what factors contribute to its prevalence. Understanding the magnitude of alarm fatigue in Pakistani ICUs is essential for designing policies that strengthen patient safety and enhance nurses' well-being. By identifying its prevalence and contributing factors, healthcare administrators can develop evidence-based strategies to reduce non-actionable alarms, refine clinical workflows, and improve nurses' psychological resilience. Such improvements have the potential not only to enhance patient outcomes but also to optimize ICU performance and workplace satisfaction among nurses. Therefore, this study aims to assess the prevalence of alarm fatigue among critical-care nurses working in a tertiary-care private hospital, addressing a critical evidence gap and providing data to support future alarm-management interventions.

METHODS

This study employed a cross-sectional descriptive design to assess the prevalence of alarm fatigue among registered nurses working in the critical care units of Hameed Latif Hospital, Lahore. The hospital was selected due to its high technological workload and reliance on continuous patient monitoring systems, making it an appropriate environment for examining alarm-related burdens among nursing staff. The study population consisted of all critical care nurses who were actively employed during the data collection period, and a total sample of 123 participants was included using a census-based approach, as this represented the full accessible population meeting the inclusion criteria at the time. Participants were eligible if they had completed a minimum of six months of experience in a critical care setting, as this duration ensured adequate exposure to alarm systems and clinical workflows. Both male and female registered nurses were included. Nurses belonging to other professional categories, such as LHVs, as well as those unavailable due to leave, were excluded

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to ensure consistency in clinical exposure and responsibilities. Data were collected using a structured questionnaire comprising two sections. The first section gathered demographic information including age, gender, marital status, and years of critical care experience. The second section assessed alarm fatigue using an adopted alarm fatigue questionnaire previously utilized in international studies. The tool measured alarm fatigue across multiple dimensions using a five-point Likert scale ranging from "Never" to "Always," with total possible scores ranging from 0 to 52. Based on established scoring thresholds, 0–7 indicated no alarm fatigue, 8–20 low fatigue, 21–32 moderate fatigue, and 33–52 severe fatigue. These categories allowed classification of alarm fatigue prevalence within the study population. The tool was used due to its prior application in similar research settings, although reliability and authorship details were not published in the available documentation. Data collection was conducted through in-person distribution of questionnaires, following a brief verbal explanation of the study purpose. Participation was voluntary, and clarification was provided to respondents where needed to ensure completeness and understanding. All completed questionnaires were collected immediately to minimize loss of data and maintain accuracy. Data analysis was performed using descriptive statistical methods. Frequencies, percentages, means, and standard deviations were calculated to summarize the demographic characteristics and alarm fatigue levels. Statistical analysis was conducted using appropriate software to ensure accuracy and adherence to quantitative research standards. Ethical approval for the study was obtained from the Ethical Review Committee of the University of Lahore. Written informed consent was obtained from all participants prior to data collection. Confidentiality was strictly maintained, and no identifying information was recorded. Participants were assured that there were no risks associated with participation and that they had the right to withdraw at any time without penalty.

RESULTS

A total of 123 critical care nurses participated in the study. The demographic characteristics showed that most respondents were female, representing 63.4% of the sample, while 36.6% were male. The largest proportion of participants belonged to the 22–26 year age group (48.8%), followed by 27–32 years (38.2%). A smaller proportion fell within 33–38 years (13.0%), and no participants were older than 38 years. Most nurses were unmarried (73.2%), while 26.8% were married. Regarding work experience in critical care, 61.0% had 1–5 years of experience, 23.6% had 6–10 years, 13.8% had six months of experience, and only 1.6% had more than 10 years of experience. The assessment of alarm fatigue revealed varied response patterns across the 13 items of the alarm fatigue questionnaire. Nearly half of the participants (47.2%) reported that they "always" readjust alarm limits based on patient symptoms, while 29.3% indicated doing so "usually." Only a small proportion (2.4%) reported "never" doing so. A considerable percentage (31.7%) indicated that they "never" turned off alarms at the start of a shift, whereas 17.9% reported "always" turning them off. Regarding noise perception, 39.8% "usually" heard a high level of noise in the ward and 29.3% "always" heard such noise. Similarly, 34.1% "usually" believed that much of the noise originated from monitoring equipment alarms, while 30.9% consistently believed so.

When asked about shift-specific responsiveness, 37.4% stated that they "always" paid more attention to alarms in certain shifts, and 33.3% reported doing so "usually." A large proportion (28.5%) indicated that heavy workload "always" prevented quick responses to alarms, while 24.4% reported this "occasionally." Repeated alarms led 41.5% to become indifferent "usually," and 30.1% said this occurred "occasionally." Alarm sounds made 43.1% of respondents "never" feel nervous, although 17.1% reported this occurring "usually." Participants demonstrated differing responses toward ventilator alarm volumes, with 48.8% stating they "always" reacted differently to high- and low-volume alerts, and 28.5% reporting this "usually." When upset or nervous, 33.3% reported being "usually" more responsive to alarm sounds, whereas 7.3% "never" reacted differently. Continuous alarms caused 35.8% of nurses to "never" lose patience, yet 20.3% did so "usually." Alarm sounds prevented 35.0% of respondents from focusing on their duties "never," while 22.8% experienced this "rarely" and 13.8% experienced it "always." During visiting hours, 30.9% reported paying less attention to alarms "never," whereas 21.1% did so "rarely" and 11.4% "always." These findings collectively demonstrate substantial variation in alarm-related behavior, with several indicators suggesting moderate to high exposure to alarm fatigue among critical care nurses in the study setting.

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Table 1: Gender Distribution of Critical Care Nurse Participants

Variable	Category	Frequency	Percentage
Gender	Male	45	36.6%
	Female	78	63.4%
	Total	123	100.%

Table 2: Age Distribution of Critical Care Nurse Participants

Variable	Category	Frequency	Percentage
Age	22-26	60	48.8%
	27-32	47	38.2%
	33-38	16	13.0%
	>38	00	00%
	Total	123	100.0%

Table 3: Marital Status Distribution of Critical Care Nurse Participants

Variable	Category	Frequency	Percentage
Marital status	Unmarried	90	73.2%
	Married	33	26.8%
	Total	123	100%

Table 4: Clinical Experience Distribution of Critical Care Nurse Participants

Variable	Category	Frequency	Percentage
Experience	6th month	17	13.8%
	1-5	75	61.0%
	6-10	29	23.6%
	>10	02	1.6%
	Total	123	100.0%

Table 5: Distribution of Alarm Fatigue Responses Among Critical Care Nurses Across 13 Questionnaire Items

Item	Never F (%)	Rarely F (%)	Occasionally F (%)	Usually F (%)	Always F (%)	Mean	Std. Deviation
1. I regularly readjust the limits of alarms based on the clinical symptoms of patients.	3 (2.4)	5 (4.1)	21 (17.1)	36 (29.3)	58 (47.2)	3.1463	1.00558
2. I turn off the alarms at the beginning of every shift.	39 (31.7)	13 (10.6)	19 (15.4)	30 (24.4)	22 (17.9)	1.8618	1.52748
3. Generally, I hear a certain amount of noise in the ward.	4 (3.3)	10 (8.1)	24 (19.5)	49 (39.8)	36 (29.3)	2.8374	1.04312

Item	Never F (%)	Rarely F (%)	Occasionally F (%)	Usually F (%)	Always F (%)	Mean	Std. Deviation
4. I believe much of the noise in the ward is from the alarms of the monitoring equipment.	3 (2.4)	17 (13.8)	23 (18.7)	42 (34.1)	38 (30.9)	2.7724	1.10745
5. I pay more attention to the alarms in certain shifts.	5 (4.1)	11 (8.9)	20 (16.3)	41 (33.3)	46 (37.4)	2.9106	1.12358
6. In some shifts the heavy workload in the ward prevents my quick response to alarms.	10 (8.1)	23 (18.7)	30 (24.4)	25 (20.3)	35 (28.5)	2.4228	1.29948
7. When alarms go off repeatedly, I become indifferent to them.	6 (4.9)	19 (15.4)	37 (30.1)	51 (41.5)	10 (8.1)	2.3252	0.99586
8. Alarm sounds make me nervous.	53 (43.1)	23 (18.7)	13 (10.6)	21 (17.1)	13 (10.6)	1.3333	1.44101
9. I react differently to the low-volume (yellow) and high-volume (red) alarms of the ventilator.	2 (1.6)	3 (2.4)	23 (18.7)	35 (28.5)	60 (48.8)	3.2033	0.94052
10. When I'm upset and nervous, I'm more responsive to alarm sounds.	9 (7.3)	17 (13.8)	37 (30.1)	41 (33.3)	19 (15.4)	2.3577	1.12447
11. When alarms go off repeatedly and continuously, I lose my patience.	44 (35.8)	24 (19.5)	20 (16.3)	25 (20.3)	10 (8.1)	1.4553	1.36857
12. Alarm sounds prevent me from focusing on my professional duties.	43 (35.0)	28 (22.8)	12 (9.8)	23 (18.7)	17 (13.8)	1.5366	1.47266
13. At visiting hours, I pay less attention to the alarms of the equipment.	38 (30.9)	26 (21.1)	21 (17.1)	24 (19.5)	14 (11.4)	1.5935	1.39576

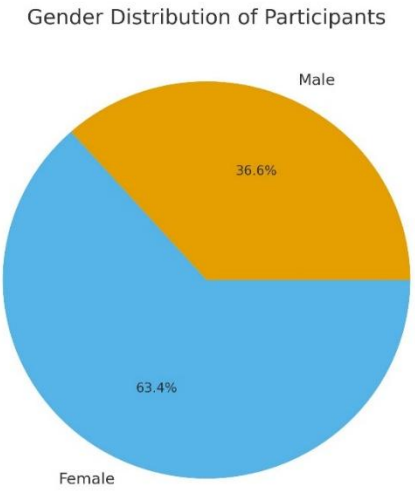

Figure 1 Gender Distribution of Participants

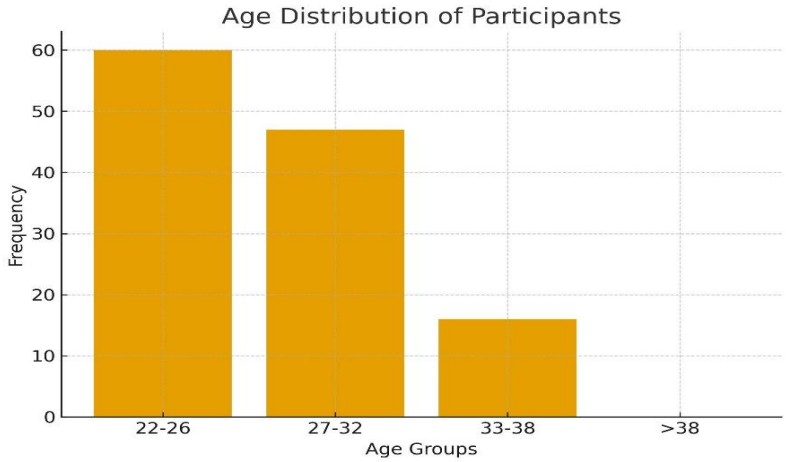

Figure 2 Age Distribution of Participants

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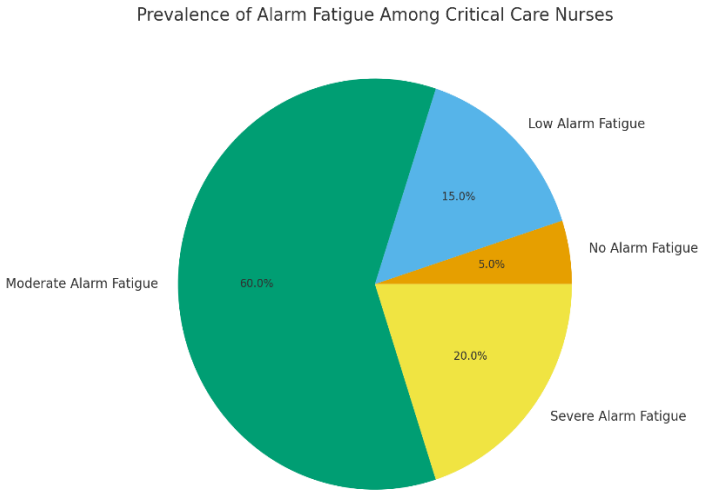

Figure 1 Prevalence of Alarm Fatigue Among Critical Care Nurses

DISCUSSION

The findings of this study demonstrated a considerable prevalence of alarm fatigue among critical care nurses, reflecting a pattern similar to that consistently reported in international literature. The nurses frequently encountered a high volume of clinical alarms, many of which were perceived as repetitive or non-actionable. This exposure appeared to contribute to desensitization, delayed responsiveness, and emotional exhaustion, aligning with global evidence that persistent and impractical alarms increase cognitive burden and negatively influence patient-care vigilance (13). Nearly half of the participants regularly readjusted alarm settings and reacted differently to high- and low-priority alarms, suggesting both familiarity with alarm patterns and a possible tendency to become less sensitive to continuous alerts. The proportion of nurses who reported becoming indifferent after repeated alarms further reinforced the cumulative impact of alarm overexposure. A similar pattern has been observed in other intensive care settings where repeated alarms caused nurses to lose patience, experience mental fatigue, and disengage from alarm systems. This behavioural shift often developed when staff were overloaded or pressured, leading to coping mechanisms that compromised alarm responsiveness (14,15). The demographic profile of the study population may have contributed to the intensity of alarm fatigue observed. A substantial majority were young, unmarried, and relatively early in their critical care careers. Younger nurses with limited ICU experience have consistently been identified as more susceptible to alarm fatigue due to lower clinical exposure, less confidence with alarm management, and heightened stress sensitivity (16). The present findings supported this pattern, particularly as 61% of the participants had fewer than five years of experience in critical care.

An additional challenge identified in this study was the behaviour of disabling alarms at the start of a shift, reported by a noticeable proportion of participants. Although this action may have been intended to regulate the alarm load, it raised concerns about safe monitoring practices and the potential delay in detecting genuine clinical deterioration. Similar patterns have been previously documented, where nurses experiencing fatigue relied on maladaptive strategies to cope with overwhelming alarm volume, often compromising patient safety (17,18). Heavy workload emerged as another contributing factor, with many nurses indicating that busy shifts limited their immediate response to alarms. High-intensity workloads have been shown to correlate strongly with alarm fatigue and occupational stress, highlighting the need for enhanced staffing models and supportive workplace environments (19-21) Although the study presented meaningful insights, several strengths and limitations merit consideration. A key strength was the inclusion of a complete and diverse sample of critical care nurses within the selected hospital, allowing a comprehensive representation of the local ICU nursing workforce. The use of a structured instrument that measured multiple behavioural and perceptual aspects of alarm fatigue provided additional depth to the findings. Another strength was the contribution of original evidence from Pakistan, a context where alarm fatigue remains under-documented despite increasing technological reliance in ICU settings. However, the study was limited by the reliance on self-reported data, which could be influenced by social desirability or recall bias. The cross-sectional design restricted the ability to establish causal relationships between workload, experience level, and alarm fatigue severity. Furthermore, the absence of objective alarm data, such as alarm frequency logs or response-time audits, limited the ability to triangulate findings with actual alarm

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behaviours. The study also did not explore the association between demographic variables and alarm fatigue through inferential analysis, which could have provided more nuanced insights into risk predictors. Another limitation was the use of an adopted questionnaire without documented reliability measures accessible within the study context.

The implications of these findings underscore the urgent need to strengthen alarm management strategies in critical care environments. Effective interventions may include structured alarm management programs, optimization of device alarm configurations, minimization of unnecessary alerts, and comprehensive training to enhance nurses' confidence in distinguishing clinically relevant alarms. Equally important is addressing occupational stress and workload through improved staffing and psychological support systems, as both factors appear to influence alarm fatigue significantly. Technological advancements that filter or prioritize alarms may also contribute to safer and more manageable alarm environments. Future research would benefit from incorporating objective alarm data, longitudinal designs to track changes in alarm fatigue over time, and intervention-based studies evaluating the effectiveness of structured alarm-management protocols. Examining the relationship between alarm fatigue and patient outcomes could also offer more compelling evidence regarding the clinical significance of the phenomenon (22). Expanding research across multiple hospitals would support broader generalizability within the Pakistani health-care system. Overall, the study provided critical insights into the prevalence and behavioural manifestations of alarm fatigue among critical care nurses in a technologically demanding ICU environment. It highlighted the need for system-level improvements, targeted training, and institutional support to safeguard nurses' well-being and promote safer alarm-responsive clinical practice.

CONCLUSION

This study concluded that alarm fatigue is a significant and pervasive concern among critical care nurses at Hameed Latif Hospital, reflecting the broader challenges seen in technology-driven intensive care environments. The findings indicated that despite nurses' efforts to manage and interpret alarm systems effectively, repeated exposure to non-actionable and intrusive alarms contributed to desensitization, stress, and compromised responsiveness, ultimately posing a threat to patient safety. The results highlighted the urgent need for structured alarm-management training, improved staffing patterns, technological refinement to reduce unnecessary alarms, and psychological support to mitigate burnout. By identifying the prevalence and contributing factors of alarm fatigue in a local context where the issue remains under-studied, this research provides essential groundwork for developing targeted interventions that strengthen nurse well-being and enhance the safety and quality of care for critically ill patients.

AUTHOR CONTRIBUTION

Author	Contribution
Rashid Tariq*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Asher Hayat	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Shan Pervaiz	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Shetal Aslam	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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