

# Alarm Fatigue Among Healthcare Workers Working in Intensive Care Unit: A Cross-sectional Study

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## Abstract

**Introduction:** Alarm fatigue, characterized by desensitization to alarms, is a prevalent issue among healthcare workers (HCWs), particularly those in intensive care units (ICUs). The constant exposure to device-related alarms both genuine and false can significantly impact human health and behavior. In this study, the consequences of alarm fatigue delve into and its effects on HCWs.

**Methods:** This descriptive analytic study was conducted in different ICUs of Shree Birendra Hospital, Kathmandu, Nepal from 1 February, 2024 to 1 March, 2024. Data was collected by using standard Charite Alarm Fatigue Questionnaire (CAFQ) Likert scale based response was collected from all the participants and the data were analyzed.

**Results:** Total 87 HCWs working in ICU had participated in this study. 57 (65.5%) participants were working in ICUs for more than one year. 76 % participants were working for 12 hours per day. 55 (63%) knew about alarm fatigue, three (3.4%) had never heard about alarm fatigue and remaining 20 (33%) had minimum prior knowledge. In this study, it was found that 29 (33.7%) ICU working staffs were having alarm fatigue with, score range (18 - 27). In 50%, alarm made them confused, triggered physical symptoms in 36 (41%), reduced concentration in 34 (39%), and interruption workflow in 27 (31%) of HCWs.

**Conclusions:** Alarm in ICUs poses a significant fatigue in HCWs (33.7%). Balancing patient safety with minimizing alarm burden requires a multifaceted approach. By addressing alarm management systematically, the consequences of alarm fatigue can mitigate and enhance patient care.

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## INTRODUCTION

Intensive care units (ICUs) are high-pressure environments where doctors and nurses work tirelessly to take care of critically ill patients. Medical devices such as heart monitors, ventilators, and infusion pumps are vital tools in the ICU.<sup>1</sup> Alarms in medical devices are designed to provide early warning to clinicians and nurses about potential problems in patient's condition.<sup>2</sup> Alarms are generally triggered by drop in oxygen saturation, an irregular heartbeat, rise and fall in blood pressure and alteration in mechanical ventilator settings, alerting the medical staffs to take prompt actions. Constant stream of alarms can be overwhelming for

medical staffs. The sheer number of alarms generated by medical devices can lead to alarm fatigue, where medical staffs may become desensitized to the alarms and may ignore them altogether.<sup>3</sup> False alarms meaning noise and artifacts from patient movement, power line interference, electrode contact noise, and data collecting device noise, in particular, can be a major source of stress and mental fatigue for medical staffs.<sup>4</sup> Responding to these alarms can be time-consuming and disrupt patient care, ultimately leading to burnout and high turnover rates.<sup>5</sup>

To address these issues, healthcare providers are exploring ways to reduce the number of false alarms and ensure that medical staffs are not overwhelmed by the constant stream of alarms. These include implementing algorithms that can filter out false alarms, adjusting alarm settings to better suit individual patients, and providing training to medical staffs on how to effectively respond to alarms. The aim of this study is to investigate alarm-related fatigue among HCWs and the impact of alarm fatigue on their physical and behavioral responses.

**METHODS**

A cross-sectional, descriptive, analytical study was conducted in ICUs of Shree Birendra Hospital between 01 February 2024 and 01 May 2024. All the health care workers working in ICU were enrolled in this study using census method. The original version of the Charite Alarm Fatigue Questionnaire (CAFQ) was used “A brief questionnaire for measuring alarm fatigue in nurses and physicians in intensive care units”.<sup>6</sup> The questionnaire comprised of nine questions with the Likert scale being coded from zero to four (zero being “I do not agree at all” and four being “I very much agree”). Question (6 - 9) was scored in a reverse direction (zero being I agree very much and four being I do not agree at all). The total score ranged from 0 (no alarm fatigue at all) to 36 (extreme alarm fatigue), with 18 being the midpoint, score of 18 or more was consider to have alarm fatigue. Data was collected using a pro forma, then the collected data was entered in Excel Worksheet 2016 and analyzed using Statistical Package for Social Science (SPSS) version 20. Categorical data was presented in frequency and percentage and continuous data was presented in mean and standard deviation. Ethical approval was taken from Institutional Review Committee (IRC) of Nepalese Army Institute of Health Sciences prior to the study. Only participants willing to take part were included in the study and written informed consent was obtained from them. Study population were medical officers and ICU nurses working in ICU and CCU for minimum of eight hours per day for at least three months. Similarly, other HCWs meeting the above inclusion criteria were enrolled.

**RESULTS**

Among the 87HCWs from ICUs participating in this study, 76 (87%) of them were working for more than 12 months in the same ward with mean working eight hours per day. Regarding participants prior knowledge to alarm fatigue, 55 (63%) of them were aware, 20 (33%) had some knowledge and three (3.4%) had never heard about it (Table 1).

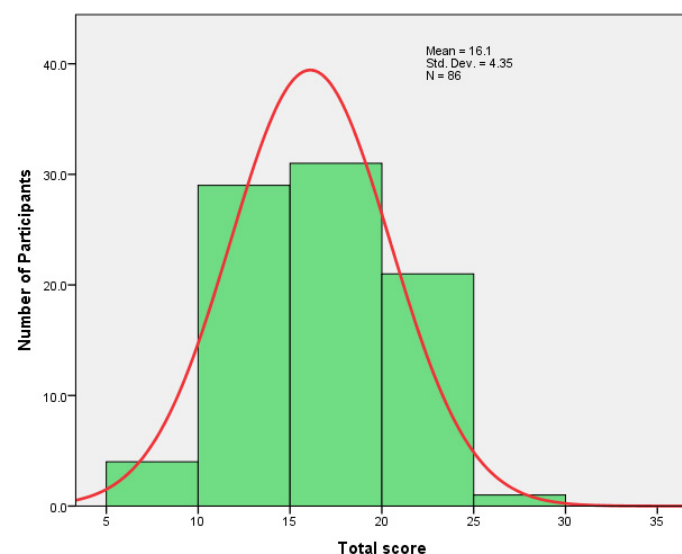
**Table 1:** Knowledge about alarm fatigue of health care workers (N = 86)

Parameters	Never heard	No prior knowledge on alarm fatigue	Knows about alarm fatigue
Number	3	20	63
Mean score	20.00	16.55	15.78
Std. deviation of score	3.464	4.27	4.36

In nine Likert scale questionnaires on alarm fatigue, 86 (98.8%) completed the responses. Overall mean fatigue score was 16.1 (Figure 1) of which 29 (33.7%) were on fatigue score range (18 - 27) (Table 2)

**Table 2:** Total alarm fatigue score (N = 86)

Score	No. of participants (%)
0 - 9	4 (4.7%)
9 - 18	52 (61.6%)
18 - 27	29 (33.7%)
27 - 36	0 (0)
Total	86 (100%)



**Fig 1:** Histogram showing fatigue score

About questionnaire regarding physical response, 50% responded that there were situations when alarms confused or triggered physical symptoms, such as nervousness, headaches, sleep disturbances (41%), reduced concentration and attention (39%), and interruption in workflow (31%). However, there was no correlation found between prior knowledge on alarm fatigue, duration of work and incidence of alarm fatigue (Table 3).

**Table 3:** Response to “Charite Alarm Fatigue Questionnaire”<sup>6</sup> (N = 86)

Sn	Statements	I do not agree at all (%)	I do not agree (%)	I agree in part (%)	I agree (%)	I very much agree (%)	Mean score
1	With too many alarms on my ward, my work performance and motivation decreases.	6 (6.89)	16 (18.39)	38 (43.67)	26 (29.8)	1 (1.1)	2.02
2	Too many alarms trigger physical symptoms for me, e.g, nervousness, headaches, sleep disturbances.	3 (3.5)	15 (17.4)	25 (29.1)	36 (41.9)	6 (7.0)	2.29
3	Alarms reduce my concentration and attention	3 (3.5)	26 (30.2)	12 (14.0)	34 (39.5)	4 (4.7)	1.98
4	My or neighbouring patients' alarms or crisis alarms frequently interrupt my workflow	2 (2.3)	25 (29.1)	21 (24.4)	31 (36.0)	6 (7.0)	2.19
5	There are situations when alarms confuse me	5 (5.8)	16 (18.6)	18 (20.9)	43 (50.0)	3 (3.5)	2.27
6	In my ward, a procedural instruction on how to deal with alarms is regularly updated and shared with all staff	11 (12.8)	16 (18.6)	19 (22.10)	37 (48.0)	3 (3.5)	2.01
7	Responsible personnel respond quickly and appropriately to alarms	1 (1.2)	2 (2.3)	13 (15.10)	47 (54.7)	19 (22.1)	0.98
8	The audible and visual monitor alarms used on my ward floor and cockpit allow me to clearly assign patient, unit, and urgency	0 (0)	6 (7)	15 (17.4)	55 (64.0)	10 (11.6)	1.2
9	Alarm limits are regularly adjusted based on patients' clinical symptoms (e.g, blood pressure limits for condition after bypass surgery).	1 (1.2)	12 (14.0)	12 (14.0)	55 (64.0)	6 (7.0)	1.38

## DISCUSSION

Alarm fatigue is a well-known concept among nurses and doctors working in the ICU. Most of the ICU staff knew how to mitigate the effects of alarms on their daily lives in terms of physical, mental, and emotional well-being. However, HCWs cannot ignore these actionable alarms at the cost of patient safety, as doing so can result in self-alarm fatigue.<sup>7</sup> In this study, 65.5% of staff were working in ICU for more than one year and mean duration of work was eight hours per day. Workload and duration was comparable with an study which has reported burn out and stress in 80% HCWs of ICU.<sup>8</sup>

Alarms are falsely triggered by many factors, including noise and artifacts from patient movement, power line interference, electrode contact noise, and data collecting device noise. According to Drew et al, the false alarm ratio in ICUs can be as high as 88.8%. Falsely triggered alarms become an unseen threat in ICUs for they not only lead to sleep deprivation, inferior sleep structure, stress for both patients and staff and depressed immune systems, but also put patients at risk for the desensitization to warnings and slow response times.<sup>9</sup> By contrast, only 2 - 9% of all ICU alarms are correctly triggered and these alarms do require an urgent and professional response.<sup>10</sup> In our study, 25 - 35% of the participants agree that having too many

alarms, whether true or false, creates more confusion among them and triggers various physical symptoms such as headaches, sleep disturbances, nervousness, and anxiety. Only 22% of those surveyed strongly believe that these alarms should be addressed immediately.

While analyzing all nine standard alarm fatigue questionnaires, majority reported that too much alarm created confusion, reduced concentration, led to interruption in work flow or resulted in physical symptoms. Our findings contrast with the more comprehensive study by Salameh Bet al<sup>11</sup>, which investigated the relationship between alarm fatigue and perceived stress among healthcare workers, incorporating detailed analyses of both perceived stress scores and alarm fatigue scores. Over all response score of alarm fatigue was 33.7% which is almost similar to the study done by Regmi et al.<sup>12</sup> Our study revealed that the mean total score of the alarm fatigue scale fatigue score of 23.3. This indicates that healthcare workers in our setting have a better capability to cope with alarm fatigue. This result may be attributed to factors such as longer work experience, institution-specific training, effective team dynamics, and workplace adaptations that reduce alarm-related stress.

The lack of specific alarm threshold settings and the high frequency of inactive or constant alarms in intensive care units inevitably leads to depersonalization due to emotional overload among nurses consequently. This may lead the nurses to resort to risky measures, which significantly compromise patient safety and well-being.<sup>13</sup> Systematic alarm management in the ICU environment without compromising patient safety is the only way to reduce alarm fatigue. Many ICUs have protocolized alarm management. The 2020 Practice Guide for Clinical Alarm Management in China suggests that hospitals should consider using Internet of Things (IoT) technology, signal filtering technology, advanced alarm generation algorithms, and AI systems to enhance alarm management.<sup>14</sup> In a 2023 study, Gul G and colleagues used a meta-analysis to evaluate the effects of interventions in ICU alarm management. They found that the interventions had a very weak effect on reducing the number of alarms and no impact overall. Further studies are needed for conclusive remarks.<sup>15</sup>

This study has several limitations. It was conducted on a limited population, predominantly composed of experienced staff who had worked in the same ICU environment for an extended period. Their familiarity with the alarm systems and established coping strategies may have reduced the perceived impact of alarm fatigue. Larger studies involving diverse populations with varying levels of experience and exposure to different ICU settings are needed to validate these findings and provide a more comprehensive understanding.

## CONCLUSIONS

Alarm-related devices in the ICU play a critical role in patient safety. However, the burden of alarm fatigue among ICU staff is significant, which can compromise the quality of patient care. Based on the findings of this study, it is crucial to prioritize efforts aimed at identifying and implementing strategies to mitigate the impact of alarm fatigue in ICUs.

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