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EMPIRICAL RESEARCH QUANTITATIVE

Alarm Management Practices Among Intensive Care Nurses: An Observational Study

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ABSTRACT

Background: Alarm fatigue has the potential to have significant consequences for patient safety, and the critical role of intensive care nurses in alarm management is an important component of this process.

Objectives: This study aimed to investigate the alarm management practices of intensive care nurses.

Design: This study utilised an observational design.

Methods: The study was conducted in the intensive care unit of a university hospital in western Türkiye with 21 nurses. To avoid influencing their behaviour, the primary purpose of the observation was not disclosed to the nurses. Two observers used an observation form to record alarms, nurse interventions and intervention times. Environmental noise levels were also measured and recorded during the observation periods.

Results: Over 118 h of observation, 460 alarms were recorded. Most alarms (80.4%) were generated by monitors, and 36.3% were due to deviations in the patient's clinical status. It was found that 53.3% of alarms were not responded to, and 73.7% were controlled. Environmental noise levels ranged from 41.90 to 83.10 dB.

Conclusions: The control, intervention and response times to alarms by intensive care nurses varied based on the alarm cause and their workload at the time. High environmental noise levels were also observed, which may impact alarm response.

Implications for Practice: The centralised location of the nurses' station, preparation of treatments at the bedside and proximity to patients contribute positively to alarm management. Recommendations to reduce technical alarms include appropriate device calibration; secure technical connections; and appropriate use of ECG electrodes, sensors and medical supplies. Setting appropriate alarm limits by primary nurses and evaluating ICU noise levels for necessary adjustments are crucial.

Reporting Method: The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklists.

Patient Contributions: No patient or public contribution.

1 | Introduction

In intensive care units (ICUs), continuous monitoring is essential to detect critical changes in patients' health and guide their daily treatment. This monitoring is facilitated by various devices connected to patients (Poncette et al. 2019; Jeong and Kim 2023). Audible and visual alarms from these devices alert healthcare providers to changes in patient conditions (Jeong and Kim 2023; Wang et al. 2023; Imhoff et al. 2009). Managing multiple devices for a single patient is common in ICUs (Jeong and Kim 2023;

Summary

- What does this paper contribute to the wider global clinical community?
  - The time it takes intensive care unit nurses to review, intervene and respond to alarms varies depending on the cause of the alarm.
  - It was found that alarms were responded to more quickly in emergency situations.
  - Proximity of patient beds to the central nurse station and treatment centre may positively contribute to nurse alarm response times and patient intervention.
  - Environmental noise levels were found to be well above recommended limits, especially during daytime working hours due to increased staff presence and activity.
  - Optimisation of alarm systems should be ensured, and planning should be established in practice areas to reduce unnecessary alarms.
  - Training plans and alarm management protocols should be established among clinical managers on alarm management strategies.

Imhoff et al. 2009). Monitoring devices such as patient monitors track vital signs, while therapeutic devices like ventilators support organ function and administer treatments (Imhoff et al. 2009). A typical ICU may have over 40 alarm sources, including patient monitors, ventilators, pulse oximeters, infusion pumps, feeding pumps, automatic syringes and dialysis systems (Korniewicz and Kenney 2017). Advances in technology have increased the number and use of alarming devices (Wang et al. 2023).

The purpose of these audible alerts is to attract the attention of caregivers. However, when these alarms are simultaneous, loud and continuous, and in the case of false alarms, the noise level generated by these alerts can be excessive (Scott et al. 2019). As the use of alarming devices rises, particularly in ICUs, the environment becomes increasingly noisy and stressful, potentially distracting caregivers (Korniewicz and Kenney 2017). An excess of alarms can lead to desensitisation and alarm fatigue, causing alarms to be silenced, disabled or ignored (Jeong and Kim 2023; Ding et al. 2023). Alarm fatigue is a significant cause of alarm-related patient harm, as it leads to decreased awareness and missed interventions (Hravnak et al. 2018). Clinical alarm systems are designed to ensure patient safety by alerting caregivers to problems (The Joint Commission 2021; Elhessewi and Eldin 2017). However, constant exposure to alarm sounds can result in caregivers ignoring alarms or experiencing deteriorated task performance due to increased workload and complexity (Ding et al. 2023; Feder and Funk 2013). Silencing or ignoring alarms due to fatigue poses a risk to patient safety (Jeong and Kim 2023; Ding et al. 2023; Feder and Funk 2013; Uçak et al. 2025; Al Nusair et al. 2025).

The US Emergency Care Research Institute's 2014 report on health technology hazards underscored the risks of alarm fatigue, where clinical devices can produce hundreds of alarms per patient daily, potentially overwhelming and desensitising healthcare providers (Jones 2014; Mirhafez et al. 2019). The US Food and Drug Administration (FDA) reported 566 alarm-related fatalities in US hospitals between 2005 and 2008, thus emphasising the critical impact of alarm fatigue on patient outcomes (Jones 2014; Bridi, Louro, and Silva 2014). For example, in over 73 documented alarm-related deaths including 33 cases tied to multiparametric monitors used in ICUs (Bridi, Louro, and Silva 2014; Cvach 2012). A well-known incident involved a case in 2010, in which a patient tragically passed away when alarms indicating a heart rate drop went unaddressed for approximately 20 min (Wallis 2010).

Whilst the phenomenon of alarm fatigue is most prevalent among healthcare professionals, its consequences for patient safety are of particular significance within the context of intensive care. The pivotal role of ICU nurses in the management of alarms renders effective alarm management a critical aspect of patient safety. The present study aims to observe and describe the alarm management practices of nurses working in the ICU. The study will report on the types of alarms, their frequencies, response times and noise levels, without implementing any interventions. The ultimate objective is to facilitate a more profound comprehension of contemporary practices, with a view to informing future enhancements in the domain of clinical alarm management.

Study questions:

- What are the primary sources and types of alarm signals in the ICU, and which devices are most frequently responsible for triggering these alarms?
- How do ICU nurses respond to and manage these alarms, and what are the typical response times observed?
- What are the measured levels of environmental noise within the ICU during designated observation periods?

2 | Methods

2.1 | Study Design and Setting

This observational study took place in the Anesthesiology and Reanimation ICU of a university hospital in western Türkiye, from April to May 2022. The ICU where the observations were made is a tertiary ICU; it consists of three parts, and a total of 67 nurses work in the unit. The first unit has a capacity of 14 beds, the second unit eight beds and the third unit five beds. Each bedside is equipped with patient care and support devices, as well as the requisite equipment. A patient cabinet and drawer are situated at the end of each patient's bed, containing medications and other necessary items. Additionally, a computer screen is located at the edge of each patient's bed, which serves as a monitor for the information system used to track and record patient information and follow-up treatment data. In addition, each unit is equipped with central monitors for patient monitoring and a nurses' station that serves as a hub for patient care equipment.

2.2 | Sample of the Study

Based on a nurse response rate of 24.04%, the number of alarms to be monitored was determined as 494, with an effect size of 0.1, a significance level of 0.01, a power of 99%, and a ±10% change in G*Power (Dursun Ergezen and Kol 2020). The study involved 21 volunteer nurses. The number of nurse participants was determined by referencing analogous studies that had been conducted in the past (Dursun Ergezen and Kol 2020; Ceylan et al. 2021). Each of the 21 nurses participating in the study was observed during all three shifts (08–16, 16–24, 24–08) to ensure consistency and to capture shift-related variations in alarm management practices. The study was conducted with nurses who were actively employed in the ICU during the observation period and who volunteered to participate in the study. The rationale for conducting the evaluation over three different working hours was to ensure that the observations covered separate shifts, namely day, evening and night. By the end of the study, 460 alarms were recorded.

2.2.1 | Inclusion Criteria

Working in the current ICU for at least 1 year, being active in the observation process and volunteering to participate in the study.

2.3 | Data Collection

Each nurse, along with the devices associated with their assigned patients, was observed individually for 2 h on separate days across all three shifts. Observations were carried out by the principal investigator and another nurse with ICU experience. Prior to each observation, an information sheet was completed capturing relevant nursing details and contextual patient-related data such as the number of patients under the nurse's care and the types of monitoring devices used (e.g., ECG monitors, ventilators and infusion pumps). During the observation, alarms and the corresponding nurse responses were recorded using a structured form, informed by a comprehensive literature review and expert input. The methodology for data collection is outlined in Figure 1.

2.4 | Data Collection Tools

2.4.1 | Observation Information Form

Developed by the researchers based on literature and expert recommendations (Dursun Ergezen and Kol 2020; Storm and Chen 2021; Vreman et al. 2020; Fleischman et al. 2020; Oliveira et al. 2018; Andrade-Méndez et al. 2020), this form included information about the observed nurse, the patient and the observation timing.

2.4.2 | Observation Form

Created by the researchers using previous observational studies and expert input (Dursun Ergezen and Kol 2020; Storm and Chen 2021; Vreman et al. 2020; Fleischman et al. 2020; Oliveira et al. 2018; Andrade-Méndez et al. 2020), the form recorded the date, alarming device, causes of alarms, interventions and control measures. Nurse responses and intervention times were also

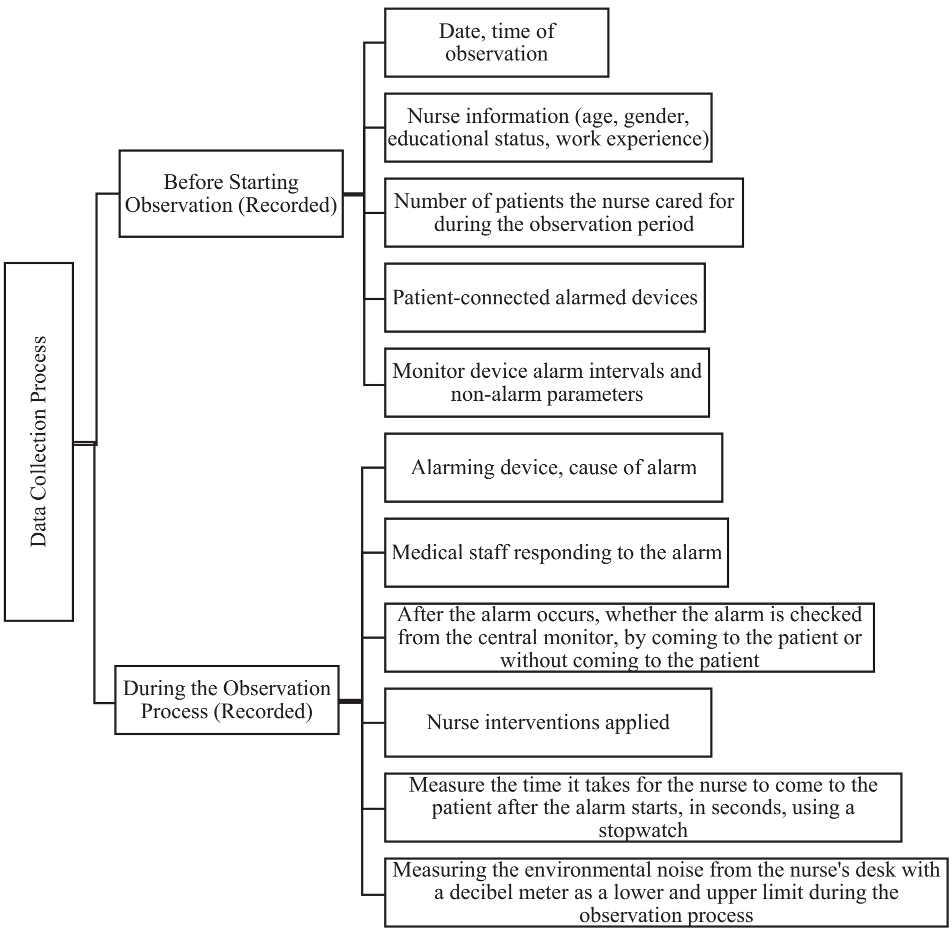

FIGURE 1 | Data collection process.

documented. To protect the observer's blindness to the data, a version of the data collection form was used in which only initials were used for statements. This was done to prevent the nurses from recognising the observed data (e.g., 'NI' for 'Nurse Intervention').

Environmental noise levels were measured during the observation period. Lower and upper limits were recorded. The measurement of environmental noise was conducted by means of a sound metre, whilst the nurses' response times to alarms were recorded using a professional stopwatch. The stopwatch was started with the alarm and stopped when the nurse or healthcare provider reached the patient, with the time recorded.

2.5 | Statistical Analysis

Data were analysed using SPSS (Statistical Package for Social Sciences) for Windows 25.0. Descriptive statistics (number, percentage, mean, standard deviation) were used to evaluate the data.

2.6 | Ethics Statement

Ethical approval was obtained from the Medical Research Ethics Committee of a university (27.01.2022 –22-1.1T/51). Institutional permission was also secured. Nurses were informed about the study's purpose, observation method, and duration, and written and verbal consent was obtained from volunteers. To reduce the Hawthorne effect, and thus not influence the nurses' behaviour, the nurses were told that the observation was for device alarms and their causes (Fleischman et al. 2020).

3 | Results

3.1 | Distribution of Results Related to Demographic Characteristics of Nurses

A total of 118 h of observations were conducted in the study, of which 42 h were conducted between 16 and 24, 42 h between 24 and 08 and 34 h between 08 and 16 working hours. Of the observations, 86 h were conducted during weekdays and 32 h during weekend working hours. Of the 21 nurses who participated in the study, 57.1% (n: 12) were female and the mean age was 28.57 ± 3.68 years. The mean work experience of the nurses was 4.83 ± 2.64 years, and the mean work experience in the ICU where the observation was performed was 3.26 ± 1.54 years (Table 1).

TABLE 1 | Distribution of results related to demographic characteristics of nurses.

Demographics characteristic	Number (n)	Percentage (%)
Gender		
Female	12	57.1
Male	9	42.9
Education status		
Licence	19	90.5
Postgraduate	2	9.5
Monthly working hours		
160 to 180	20	95.2
More than 180	1	4.8
(08–16) Number of patients cared by the nurse		
1	2	11.8
2	14	82.4
3	1	5.9
(16–24) Number of patients cared by the nurse		
1	2	9.5
2	19	90.5
(24–08) Number of patients cared by the nurse		
1	4	19.0
2	17	81.0
Age (years)	28.57 ± 3.68	
Work experience (years)	4.83 ± 2.64	
Anaesthesia intensive care work experience (years)	3.26 ± 1.54	

Note: Of the 21 nurses who participated in the observation, four nurses could not be observed during 08–16 working hours because they preferred to work 16–24 working hours.

3.2 | Results Regarding Alarms Recorded During the Observation Process

A total of 460 alarms were recorded during the study. Analysis of the distribution of these alarms according to working hours showed that 40.9% occurred during the 16–24 shift, with 77% recorded on weekdays. Among these alarms, 58% resolved spontaneously, meaning they stopped without requiring active nurse intervention. This could happen, for example, when a patient's vital signs briefly trigger an alarm but return to acceptable ranges on their own. In contrast, 18.5% of alarms were actively silenced by the nurses, indicating direct intervention (Table 2).

111 monitor devices connected to the patients cared for by 21 nurses were checked before the start of observation, and the parameters with off alarms were recorded. The analysis of off alarm parameters showed that 1.8% (n = 2) of saturation alarms, 3.6% (n = 4) of pulse alarms, 7.2% (n = 8) of blood pressure alarms, and 30.6% (n = 34) of respiration alarms were off. These alarms were already deactivated before the monitoring started.

3.3 | Results on Nurse Response Times

The study analysed the mean response times for different categories of alarms, with findings detailed in seconds. The

TABLE 2 | Distribution of results related to alarms.

Characteristic	Number (*n*)	Percentage (%)
Working hours		
08–16	146	31.7
16–24	188	40.9
24–08	126	27.4
Working day		
Weekdays	357	77.6
Weekend	103	22.4
Alarming device		
Monitor	370	80.4
Ventilator	49	10.7
Infusion pump or perfuser	30	6.5
Nutrition pump	11	2.4
Cause of alarm		
Deviations in patient's clinical condition	167	36.3
Technical reasons, contact transmission problems	109	23.7
Intervention applied to the patient	87	18.9
Device alarm limit settings	56	12.2
Running out of liquid or dose adjustment	26	5.7
Patient position	8	1.7
Deterioration of patient's general condition	2	0.4
Other	5	1.1
Who attempted respond to the alarm?		
Primary nurse	151	32.8
Nurse other than primary nurse	47	10.2
Physician	7	1.5
More than one health worker	10	2.2
No attempt	245	53.3
Alarm control[a]		
Alarm checked	339	73.7
Alarm not checked	121	26.3
Nurse intervention[b]		
Alarm silenced itself	267	58.0
Alarm silenced	85	18.5
Treatment attempted	33	7.2
Intravenous fluid changed or dose adjusted	26	5.7
Contact problems solved	19	4.1
Communicated to physician	9	2.0
Device settings changed	3	0.7
Other	18	3.9

(Continues)

TABLE 2 | (Continued)

[a]Alarm control: Checking the patient's monitor or medical device without physically going to the bedside or intervening to detect and recognise the alarm in case of an alarm.
[b]Nurse intervention: Evaluation by coming to the patient after the alarm, intervening according to the situation.

overall mean response time for nurse interventions was 83.61 ± 132.07 s, showing significant variability based on the cause of each alarm. For example, alarms triggered by 'Technical Reasons' and 'Contact Transmission Problems' had the longest mean response time at 101.07 s (SD: 118.25), indicating potential challenges in managing equipment-related alarms. Conversely, critical alarms associated with the 'Deterioration of General Condition of the Patient' had the shortest mean response time of 6.0 s (SD: 1.41), demonstrating prompt nurse response in urgent patient care scenarios. Alarms due to 'Patient Position' changes also elicited a quicker response, with a mean of 83.33 s (SD: 78.99), while alarms for 'Running Out of Liquid or Dose Adjustment' received a response in 20.3 s (SD: 13.67). This variation reflects nurses' prioritisation of patient-centred alerts, ensuring swift action for alarms directly impacting patient health. Such data underscores the need for tailored strategies to improve response efficiency across different alarm types (Table 3).

3.4 | Observation Process Results on Environmental Noise

Environmental noise levels were recorded throughout the observation period, with values documented as lower and upper limits for each shift. The highest recorded environmental noise level reached 83.10 dB (decibel) during the 08–16 shift (Table 4). Noise levels varied across shifts, with mean lower limit values recorded around 49.32 dB for the day shift (08–16), 48.83 dB for the evening shift (16–24), and 47.34 dB during the night shift (24–08). Similarly, the value of the upper limit was highest in the day shift at 75.04 dB and lowest in the night shift at 72.38 dB.

4 | Discussion

The phenomenon of alarm fatigue is of particular significance within the context of intensive care, given its implications for patient safety. This issue directly impacts nurses who are responsible for patient care on a 24/7 basis. In this study, alarm types, frequencies, response times and noise levels, and nurse alarm management were observed without any intervention.

TABLE 3 | Distribution of results regarding nurse response times according to the causes of alarms (seconds, s).

Cause of alarm	Mean	SD	Min	Max	Median
Technical reasons, contact transmission problems	101.07	118.245	5	440	80.00
Patient position	83.33	78.996	24	173	53.00
Intervention applied to the patient	59.33	33.081	35	97	46.00
Deviations in patient's clinical condition	97.37	153.323	4	706	20.00
Deterioration of general condition of the patient	6.00	1.414	5	7	6.00
Device alarm limit settings	49.14	57.742	5	134	10.00
Running out of liquid or dose adjustment	20.30	13.670	5	57	15.00
Other	178.00	237.588	10	346	178.00
Average overall response	83.61	132.066	4	706	23.00

Abbreviations: Max, maximum; Min, minimum; SD, standard deviation.

The data obtained were then evaluated by comparing them with similar studies that had been published in the literature. The study found that all 111 patients observed were monitored, 85 (76.6%) were ventilated, 65 (58.5%) had infusion pumps or perfusers, and 49 (44.1%) had nutrition pumps. These findings align with a study where 98.8% of patients were connected to a monitor, 17.5% to pulse oximetry, 35% to a mechanical ventilator, 81.3% to an infusion pump, and 30% to an enteral feeding pump (Ceylan et al. 2021). The consistency in monitoring and feeding pump usage observed in this study, alongside a higher number of ventilated patients and slightly lower infusion pump use, reflects the needs and demands typical of a tertiary ICU setting. In such high-acuity environments, the fluctuations in pump usage are likely influenced by patient severity and the need for complex, resource-intensive care. Additionally, challenges such as intermittent material shortages in pump sets across the hospital may impact the availability and distribution of infusion devices. These shortages can arise due to supply chain constraints, increased demand during peak times, or budget limitations within the healthcare system, which may require prioritising devices based on patient urgency and availability. As a result, material shortages are a critical factor in both operational planning and the provision of continuous, high-quality patient care in the ICU.

When comparing the number of alarms in observational studies, various findings were noted: Cho et al. (2016) reported 2184 alarms over 48 h of observation (Cho et al. 2016). Fleischman et al. (2020) recorded 1049 alarms related to 146 patients in 53 h (Fleischman et al. 2020). Dursun Ergezen and Kol (2020) observed 1781 alarms in 328 h with 13 nurses (Dursun Ergezen and Kol 2020). Gül and İntepeler (2021) documented 1197 alarms from 2-h observations of 33 patients (Gül and İntepeler 2021). Ceylan et al. (2021) recorded 144 alarms during 80 h of observation (Ceylan et al. 2021). In our study, 460 alarms were recorded during 118 h of observation for 111 patients. The high number of alarms per patient suggests an increased workload for nurses managing multiple patients, potentially leading to reduced alarm sensitivity and increased alarm fatigue.

In a study by Gül and İntepeler (2021), less than half of the alarms were responded to by primary nurses, with many handled by more than one health personnel (Gül and İntepeler 2021). Our study found that the majority of alarm interventions were performed by primary nurses, differing from previous findings, and there were a few cases where more than one healthcare

TABLE 4 | Distribution of results related to environmental noise.

Working hours	Limit value	Mean	SD	Median	Min	Max
08–16	Lower limit value	49.32	2.74	49.30	43.60	54.20
	Upper limit value	75.04	4.53	76.20	66.50	83.10
16–24	Lower limit value	48.83	3.96	49.20	41.30	53.90
	Upper limit value	73.62	3.55	72.80	67.80	79.00
24–08	Lower limit value	47.34	2.68	46.80	41.90	52.00
	Upper limit value	72.38	4.81	72.65	64.10	79.90

Abbreviations: Max, maximum; Min, minimum; SD, standard deviation.

professional intervened. This may reflect the primary care nurse's responsibility for patient care.

Fleischman et al. (2020) reported that 31% of alarms were silenced (Fleischman et al. 2020), while Vreman et al. (2020) noted most alarms were due to exceeded limits (Vreman et al. 2020). Dursun Ergezen and Kol (2020) found that 'silencing the alarm', 'intervening in the clinical condition' and 'solving contact problems' were common intervention methods (Dursun Ergezen and Kol 2020). Gül and İntepeler (2021) reported the top responses as 'correcting the pulse oximetry device', 'checking/adjusting oxygen levels' and 'informing the physician' (Gül and İntepeler 2021). In our study, most alarms were controlled remotely or from the central monitor, with over half silencing spontaneously. Nurses evaluated alarms and intervened based on their nature, silencing alarms accordingly.

In a study with 13 registered nurses with a nurse-to-patient ratio of 1:4 and observation for a period of 328 h, alarm response times were 102.81 ± 231.12 s (Dursun Ergezen and Kol 2020). In a 40-h observation period with 88 patients, alarm response times were 4 min 54 s (day shift) and 4 min 55 s (night shift) (Bridi, Silva, et al. 2014). In a study in which 75% of the participants were nurses, the response time to alarms was 2 min 45 s, and the delay in responding to alarms was attributed to a lack of physical facilities and human resources (Pergher and Silva 2014). In our study, the mean response time was 83.61 ± 132.066 s, ranging from 6 to 706 s. Faster responses were recorded in emergency situations compared to problems with technical or equipment settings. Shorter response times may be due to the proximity of patient beds to the central nurse station and treatment centre. Another reason for faster response times may be related to the patients being cared for. The number of patients cared for by nurses on the unit is between 1 and 2, and in some exceptional cases it may be as high as 3.

In our study, the average working time of the nurses in the ICU was 3.26 ± 1.54 years. This finding coincides with the results of the present study (Dursun Ergezen and Kol 2020; Ceylan et al. 2021). The primary cause of alarm fatigue is the lack of experience and knowledge among nurses (Dursun Ergezen and Kol 2020). Consequently, the development and implementation of specific training programmes for alarm management, together with increasing the intensive care experience of nurses, represent a crucial step in the prevention of alarm fatigue.

The WHO recommends hospital noise levels below 30 dB during the day and below 40 dB at night but does not specify a separate noise level range for ICUs (Berglund et al. 1999). However, ICU noise levels often exceed these recommendations, reaching up to 70 dB (Pugh et al. 2007; Salandin et al. 2011; Simons et al. 2018; Terzi et al. 2019; He et al. 2018). A systematic review found that most ICU noise sources are electronic devices with alarms (Pal et al. 2022). Our study recorded environmental noise levels well above the recommended limits, particularly during daytime working hours due to higher staff presence and activity. High environmental noise can impair alarm management by making alarms harder to hear and identify.

5 | Limitations

The study results are limited to the ICU of a single hospital. Observations were conducted with 21 volunteer nurses, and 08–16 working hours were not observed for four nurses who preferred 16–08 working hours. Given that participation was voluntary and met the inclusion criteria, the diversity of nurse characteristics may be limited, which may limit the generalisability of the results. The limited number of infusion pump sets in the hospital restricted the number of patients using infusion pumps. The observation was only conducted for 2 h during the specified working hours. Not observing all working hours may affect the frequency of alarms and the ability to observe all nursing interventions. Regarding ambient noise, the fact that the observation was conducted during the observation period and the ambient noise in the ICU was not measured 24 h a day may affect generalisations. If the devices connected to the patient cared for by the nurse being observed give an alarm, the intervention of nurses, physicians, and other health professionals other than the primary nurse of the patient may affect the observation. In cases where nurses cared for more than one patient and the devices of the patients they cared for alarmed consecutively, the first alarm was prioritised. The main purpose of the observation was not clearly stated to the nurses before the study started. This approach was adopted to facilitate the observed nurses to maintain their behaviours in a natural way. The study was conducted meticulously. However, it cannot be ignored that some nurses may have been aware of the content and purpose of the study in the later stages of the data collection process.

6 | Conclusion

The time it takes ICU nurses to assess, intervene, and respond to the alarm can vary depending on the cause of the alarm, the patient's condition, and the nurse's workload at the time. Most interventions are performed by the nurses caring for the patient. This shows the importance of the nurses responsible for patient care 7–24 in the ICU.

Nurses' responses to alarms and intervention times may depend on the patient-to-nurse ratio, the intensity of the ICU, and the physical design of the ICU. In addition, ambient noise in the ICU is thought to be higher than recommended levels and may affect response.

Alarm management protocols should be established for ICU nurses, routine technical checks of alarm devices should be monitored, the physical design of the ICU should be designed to facilitate patient–nurse care, and the number of patients cared for by nurses should be low, especially in ICUs. Noise levels in the ICU should be monitored frequently, and ICU traffic should be controlled as much as possible, as it can interfere with nurses' ability to hear, recognise, and respond to alarms.

Author Contributions

Zuleyha Aykut: conceptualisation; data curation; formal analysis; investigation; methodology; project administration; software; visualisation; writing – original draft. **Meryem Yavuz van Giersbergen:** conceptualisation; data curation; formal analysis; methodology; project administration; supervision; validation; writing – review and editing.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Research data are not shared.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.