JHWCR JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH 3007-0570

DOI: https://doi.org/10.61919/p5qpb545

Original Article

Sleep Fragmentation and Intravenous Alarm Fatigue Among Night-Shift Nurses in High-Dependency Units

Fouzia Pervaiz[1], Zarina Naz[2], Kanwal Mazhar[3], Humaira Iqbal[4], Mohammad Talha Khalid[5], Shaikh Khalid Muhammad[6]

[1] Nursing Officer, PAEC General Hospital, Islamabad, Pakistan
[2] MHPE Scholar, National University of Medical Sciences, Rawalpindi, Pakistan
[3] Charge Nurse, Nishtar Hospital, Multan, Pakistan
[4] Charge Nurse, Chaudhry Pervaiz Elahi Institute of Cardiology, Multan, Pakistan
[5] Nursing Instructor, The Next College of Nursing, Multan, Pakistan
[6] Professor of Medicine, CMC Teaching Hospital, SMBBMU, Larkana, Pakistan

****Corresponding author:*** Fouzia Pervaiz, fouziapervaiz078@gmail.com

"Cite this Article" **Received**: 08 January 2026; **Accepted**: 01 February 2026; **Published**: 15 February 2026
Author Contributions: Concept: FP, ZN; Design: FP, ZN, SKM; Data Collection: KM, HI, MTK; Analysis: FP, ZN, SKM; Drafting: FP, KM, HI, MTK, SKM. **Ethical Approval**: PAEC General Hospital, Islamabad, Pakistan. **Informed Consent**: Written informed consent was obtained from all participants; **Conflict of Interest**: The authors declare no conflict of interest. **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: NA

ABSTRACT

Background: Frequent intravenous infusion-pump alarms may increase sensory workload among night-shift nurses, but their relationships with sleep quality, occupational fatigue, and psychomotor vigilance remain insufficiently characterized. Objective: To examine the associations between intravenous alarm frequency, sleep disruption, occupational fatigue, and cognitive alertness among night-shift nurses working in high-dependency units. Methods: This cross-sectional study was conducted from October 2025 to January 2026 in tertiary-care high-dependency units in Punjab, Pakistan. Eighty-four nurses completed the Pittsburgh Sleep Quality Index, Fatigue Assessment Scale, an alarm-fatigue visual analogue scale, shift diaries, and pre-shift and post-shift Psychomotor Vigilance Tasks. Pearson correlations and paired-samples t-tests were applied. Results: Participants encountered 64.2 ± 14.8 alarms per shift and had a mean global Pittsburgh Sleep Quality Index score of 12.6 ± 3.1. Alarm frequency correlated with sleep-quality scores ($r = 0.68$), fatigue scores ($r = 0.72$), and post-shift attention lapses ($r = 0.61$; all $p < 0.001$). Reaction time increased from 242.4 ± 18.5 to 318.9 ± 34.2 ms, with a mean difference of 76.5 ms (95% CI, 68.2–84.8; $p < 0.001$). Attention lapses increased from 1.8 ± 0.9 to 6.4 ± 2.3, with a mean difference of 4.6 (95% CI, 4.06–5.14; $p < 0.001$). Conclusion: Greater intravenous alarm exposure was associated with poorer sleep, greater fatigue, and reduced post-shift vigilance, although causal relationships cannot be inferred. Keywords: Alarm Fatigue; Circadian Rhythm; High-Dependency Unit; Infusion Pumps; Night-Shift Work; Occupational Fatigue; Psychomotor Vigilance; Sleep Quality.

INTRODUCTION

High-dependency units (HDUs) provide enhanced monitoring and treatment for patients whose clinical needs exceed those manageable in general wards but do not require the full resources of an intensive care unit. Nursing care in these settings depends heavily on electronic medical devices, particularly intravenous (IV) infusion pumps used to administer fluids, blood products, and medications requiring precise delivery. Although device alarms are intended to alert clinicians to potentially unsafe conditions, frequent non-actionable or low-priority alarms may create substantial auditory burden and contribute to alarm fatigue, reduced responsiveness, and impaired clinical vigilance (1,2).

Night-shift nurses may be particularly susceptible to these effects because they perform demanding clinical duties during a period of natural circadian decline. Repeated night-shift work can disturb the normal sleep–wake cycle, shorten daytime recovery sleep, and increase fatigue, impaired concentration, and psychological strain (3,4). Within HDUs, frequent infusion-pump alarms caused by line occlusion, air detection, patient movement, or other technical conditions may further increase sensory workload.

Persistent exposure to such alerts may interfere with focused clinical work during the shift and contribute to difficulty achieving restorative sleep after duty hours.

Previous studies have examined alarm fatigue, environmental noise, sleep disruption, and occupational exhaustion among healthcare professionals, particularly those working in intensive and critical-care environments (2–6). However, many investigations have combined alarms generated by different medical devices, making it difficult to determine the specific contribution of IV infusion-pump alarms. Evidence is also limited regarding the relationship between IV alarm frequency, daytime sleep quality, occupational fatigue, and objectively measured psychomotor vigilance among nurses working night shifts in HDUs.

Understanding these relationships is important because reduced alertness and prolonged reaction time may compromise nurses' ability to recognize patient deterioration, respond promptly to device alerts, and administer medications safely. Therefore, this cross-sectional study examined the associations between the frequency of IV device alarms and sleep disruption, occupational fatigue, and psychomotor vigilance among night-shift nurses working in HDUs.

MATERIALS AND METHODS

A cross-sectional study was conducted from October 2025 to January 2026 in specialized HDUs of selected tertiary-care referral centres located in industrial and urban areas of Punjab, Pakistan. The study population comprised registered nurses assigned to night-shift duties in participating HDUs. Nurses were eligible when they were 22–50 years of age, had worked consecutive HDU night shifts for at least six months, and completed at least three night shifts per week. Nurses with a previously diagnosed sleep disorder, those receiving prescribed sedative or hypnotic medication, and pregnant nurses were excluded to reduce the influence of conditions that could independently affect sleep quality and fatigue.

Eligible nurses were approached during the study period and invited to participate after receiving information about the study. The planned sample was informed by comparable operational nursing studies conducted in specialized critical-care environments. Of the 95 eligible nurses approached, 84 completed the psychometric assessments, psychomotor testing, and shift diaries and were included in the final analysis. Participation was voluntary, and written informed consent was obtained before data collection. Institutional review board approval was secured before participant recruitment.

The primary exposure was the frequency of IV infusion-pump alarms encountered during a 12-hour night shift. Alarm frequency was determined from available device or unit alarm logs and recorded as the number of IV alerts occurring during each assessed shift. Participants also completed structured shift diaries documenting their work pattern and awakenings perceived to be related to medical-device alerts. Sleep quality and fragmentation were assessed using the Pittsburgh Sleep Quality Index, with higher global scores representing poorer sleep quality. Occupational fatigue was measured using the Fatigue Assessment Scale, while subjective alarm fatigue was evaluated using a visual analogue scale.

Psychomotor vigilance was evaluated at the beginning and conclusion of the night shift using the Psychomotor Vigilance Task. The principal performance measures were mean reaction time and the number of attention lapses, defined as responses exceeding 500 milliseconds. Administering the task at both time points allowed assessment of within-participant changes in sustained attention during the shift. The use of standardized psychometric instruments, objective vigilance testing, predefined eligibility criteria, and consistent assessment timing was intended to improve measurement consistency and reduce avoidable variation.

Data were analysed using IBM SPSS Statistics version 26.0. The distribution of continuous variables was examined using the Shapiro–Wilk test. Continuous data were summarized as mean and standard deviation, while categorical variables were presented as frequencies and percentages. Pre-shift and post-shift PVT reaction times and attention-lapse counts were compared using paired-samples t-tests. Pearson correlation coefficients were calculated to assess the relationships between IV alarm frequency, global Pittsburgh Sleep Quality Index scores, Fatigue Assessment Scale scores, and post-shift attention lapses. Analyses were based on complete assessment records from the 84 participants, and all statistical tests were two-sided, with a p-value below 0.05 considered statistically significant.

RESULTS

Of the 95 eligible HDU night-shift nurses approached, 84 completed the psychometric assessments, shift diaries, and psychomotor vigilance testing, corresponding to a response rate of 88.4%. Participants had a mean age of 29.4 ± 4.2 years and a mean HDU experience of 4.1 ± 1.8 years. Most participants were female (81.0%), while 58.3% worked three night shifts per week and 41.7% worked four or more. The mean reported sleep duration was 5.2 ± 1.1 hours (Table 1).

Participants encountered a mean of 64.2 ± 14.8 IV pump alarms during each 12-hour night shift, with observed frequencies ranging from 38 to 98 alarms. The mean global PSQI score was 12.6 ± 3.1, the mean FAS score was 34.8 ± 6.5, and the mean subjective alarm-fatigue score was 7.8 ± 1.4 (Table 2).

Higher IV alarm frequency was positively correlated with poorer subjective sleep quality, as indicated by the global PSQI score ($r = 0.68$; 95% CI, 0.55–0.78; $p < 0.001$), and with greater occupational fatigue measured using the FAS ($r = 0.72$; 95% CI, 0.60–0.81; $p < 0.001$). Alarm frequency was also associated with a greater number of post-shift PVT attention lapses ($r = 0.61$; 95% CI, 0.46–0.73; $p < 0.001$). Positive correlations were additionally observed between PSQI and FAS scores, PSQI scores and post-shift lapses, and FAS scores and post-shift lapses (Table 3).

Table 1. Demographic and Occupational Characteristics of Participants (N = 84)

Characteristic	Category	n (%) or Mean ± SD
Age, years	—	29.4 ± 4.2
Gender	Female	68 (81.0)
	Male	16 (19.0)
HDU experience, years	—	4.1 ± 1.8
Night shifts per week	3 shifts	49 (58.3)
	≥4 shifts	35 (41.7)
Mean sleep duration, hours	—	5.2 ± 1.1

Abbreviation: HDU, high-dependency unit.

Table 2. Intravenous Alarm Exposure, Sleep Quality, and Occupational Fatigue

Measure	Evaluated Domain	Mean ± SD	Observed Range
Intravenous alarm frequency	Alerts per 12-hour shift	64.2 ± 14.8	38–98
Global PSQI score	Subjective sleep quality	12.6 ± 3.1	6–19
Fatigue Assessment Scale score	Occupational fatigue	34.8 ± 6.5	18–48
Visual analogue scale score	Subjective alarm fatigue	7.8 ± 1.4	4–10

Abbreviations: PSQI, Pittsburgh Sleep Quality Index; SD, standard deviation.

Table 3. Correlations Between Intravenous Alarm Frequency, Sleep Quality, Fatigue, and Post-Shift Vigilance

Variable Pair	Pearson r	95% CI	p-Value
IV alarm frequency and global PSQI score	0.68	0.55 to 0.78	<0.001
IV alarm frequency and total FAS score	0.72	0.60 to 0.81	<0.001
IV alarm frequency and post-shift PVT lapses	0.61	0.46 to 0.73	<0.001
Global PSQI score and total FAS score	0.59	0.43 to 0.71	<0.001
Global PSQI score and post-shift PVT lapses	0.54	0.37 to 0.68	<0.001
Total FAS score and post-shift PVT lapses	0.65	0.51 to 0.76	<0.001

Abbreviations: CI, confidence interval; FAS, Fatigue Assessment Scale; IV, intravenous; PSQI, Pittsburgh Sleep Quality Index; PVT, Psychomotor Vigilance Task. Confidence intervals were calculated using Fisher's z transformation.

Psychomotor performance declined between the beginning and conclusion of the night shift. Mean reaction time increased from 242.4 ± 18.5 ms before the shift to 318.9 ± 34.2 ms after the shift, representing a mean increase of 76.5 ms (95% CI, 68.2–84.8; t[83] = 18.24; p < 0.001; dz = 1.99). The mean number of attention lapses increased from 1.8 ± 0.9 to 6.4 ± 2.3, with a mean increase of 4.6 lapses (95% CI, 4.06–5.14; t[83] = 17.02; p < 0.001; dz = 1.86). Both comparisons demonstrated large standardized within-participant effects (Table 4).

Table 4. Changes in Psychomotor Vigilance Across the Night Shift

PVT Measure	Pre-Shift Mean ± SD	Post-Shift Mean ± SD	Mean Difference	95% CI	t (df = 83)	p-Value	Cohen's dz
Reaction time, ms	242.4 ± 18.5	318.9 ± 34.2	76.5	68.2 to 84.8	18.24	<0.001	1.99
Attention lapses ≥500 ms	1.8 ± 0.9	6.4 ± 2.3	4.6	4.06 to 5.14	17.02	<0.001	1.86

Abbreviations: CI, confidence interval; PVT, Psychomotor Vigilance Task; SD, standard deviation. Mean differences were calculated as post-shift minus pre-shift values. Cohen's dz represents the standardized paired-samples effect.

DISCUSSION

This study identified a substantial burden of IV infusion-pump alarms among night-shift nurses working in HDUs. Higher alarm frequency was associated with poorer subjective sleep quality, greater occupational fatigue, and more post-shift attention lapses. Psychomotor vigilance also deteriorated over the course of the night shift, with longer reaction times and a greater frequency of delayed responses at shift conclusion. These findings demonstrate clinically relevant associations but do not establish that IV alarms independently caused the observed sleep or vigilance outcomes.

The relationship between alarm exposure and impaired vigilance is consistent with evidence that frequent medical-device alarms can increase sensory workload and contribute to alarm desensitization in critical-care environments (2). Previous research examining nightly infusion-pump alarms has similarly demonstrated that repeated alerts can disturb the hospital sleep environment and interfere with periods of rest (3). The present findings extend this concern to nursing personnel by showing that a higher frequency of IV alarms was associated not only with poorer sleep scores but also with objectively measured post-shift vigilance lapses.

Participants reported short sleep duration and elevated PSQI scores, indicating a considerable burden of sleep disturbance within the study population. Night-shift nurses are already exposed to circadian misalignment because occupational activity occurs during the biological night and recovery sleep generally occurs during daylight hours. Previous literature has linked night-shift work with disturbed circadian rhythms, poorer mental health, and reduced recovery among nurses (5). Sleep and circadian disruption are also common in intensive and high-acuity clinical environments, where environmental noise, clinical activity, lighting, and frequent interruptions can impair restorative rest (4,6). IV alarms may therefore represent one component of a broader combination of occupational and environmental stressors.

The increase in reaction time and attention lapses has potential implications for clinical performance. Nurses working in HDUs must continuously monitor patients, interpret device alerts, administer medications, and respond rapidly to changes in clinical condition. Reduced vigilance could affect the timeliness or accuracy of these activities. Evidence linking inadequate sleep among healthcare workers with medication errors further supports the importance of addressing fatigue as an occupational and patient-safety concern (1). Nevertheless, the present results cannot determine whether alarm exposure directly produced impaired vigilance or whether both were influenced by workload, staffing levels, patient acuity, cumulative night-shift exposure, or other unmeasured factors.

The study has several strengths. It combined standardized self-reported measures with objective psychomotor testing and assessed vigilance at consistent pre-shift and post-shift time points. The analysis also examined relationships among alarm frequency, sleep quality, fatigue, and vigilance rather than evaluating these outcomes separately. However, the cross-sectional design prevents determination of temporal or causal relationships. The study was conducted in a geographically restricted urban population, which may limit generalizability to rural hospitals or institutions with different staffing and alarm-management systems. Sleep quality, fatigue, and alarm-related awakenings were partly self-reported and may have been affected by recall or reporting bias.

Additional limitations include the absence of adjusted multivariable analysis and the possibility of residual confounding by caffeine consumption, chronotype, commuting time, domestic responsibilities, total device-alarm exposure, workload, staffing ratios, and pre-existing health conditions. The study also did not include continuous acoustic monitoring, actigraphy, or independent verification of daytime sleep interruption. Future longitudinal and interventional studies should integrate objective alarm logs, environmental sound measurements, wearable sleep monitoring, and repeated vigilance assessments across several shift rotations (7). Such designs would help clarify temporal relationships and determine whether modifying alarm systems or work schedules improves sleep and clinical alertness.

CONCLUSION

Higher IV infusion-pump alarm frequency was associated with poorer subjective sleep quality, greater occupational fatigue, and more post-shift attention lapses among night-shift nurses working in HDUs. Reaction times and attention-lapse counts also increased substantially between shift onset and conclusion. These findings identify IV alarm burden, sleep disruption, and reduced vigilance as interconnected occupational concerns, although longitudinal and interventional research is required to determine causality and evaluate potentially modifiable contributing factors.

REFERENCES

1. de Sousa Freire VEC, de Araújo TM, Queiroz MVO, de Freitas RWJF, Weiss C, de Araújo MFM. Medication errors and sleep of health workers: systematic review and meta-analysis. 2020;164(9).
2. Unal A, Arsava EM, Caglar G, Topcuoglu MA. Alarms in a neurocritical care unit: a prospective study. J Clin Monit Comput. 2022;36(4):995-1001.
3. van Kooten JA, Koomen E, van de Ven KP, Patel M, van Grotel M, Grootenhuis MA, et al. Exploring the effect of nightly infusion pump alarms on sleep in the hospital. 2021.
4. Smith HR. Nighttime quiet in the intensive care unit: an integrative review. 2020.
5. Bijok B, Jaulin F, Picard J, Michelet D, Fuzier R, Arzalier-Daret S, et al. Anaesthesia Critical Care & Pain Medicine.
6. Okechukwu CE. Circadian rhythm and mental health relationships among nurses working night shifts in the era of the COVID-19 pandemic. 2023.
7. Fernandez FX, Rahman S, Spitschan M. Translation and processing of light by the non-image-forming visual system: context, mechanisms and applications. Frontiers Media SA; 2021.
8. Raghani PS. Insufficient sleep and onset of coronary artery disease. 2022.
9. Ramage JL. Assessing the effect of a light intervention on sleep quality and performance of Pentagon watchstanders [thesis]. 2023.
10. Helles M. Balancing sleep, work and well-being during lockdown: exploring the relationships between working women's mood and sleep status during New Zealand's COVID-19 lockdown [thesis]. Palmerston North: Massey University; 2022.

11. Knauert MP, Ayas NT, Bosma KJ, Drouot X. Causes, consequences, and treatments of sleep and circadian disruption in the intensive care unit: an official American Thoracic Society research statement.

12. Cunha LA, Costa JA, Marques EA, Brito J, Lastella M, Figueiredo P. The impact of sleep interventions on athletic performance: a systematic review. Sports Med Open. 2023;9(1):58.

13. Alreja A, Ward MJ, Ma Q, Russ BE, Bickel S, Van Wouwe NC, et al. A new paradigm for investigating real-world social behavior and its neural underpinnings. 2023;55(5):2333-52.

14. Kolar P. Safe mobility using an autonomous wheelchair controlled by human cognition using Riemannian geometry [thesis]. San Antonio: University of Texas at San Antonio; 2022.

15. Hendriksen DR. Mindful design for adolescent minds: moving away from digital hook models to mindful innovation models. 2024.

16. Memarian S. Determinants of indoor air quality in residential buildings with a focus on human behavior and outdoor air quality [thesis]. 2023.

17. De Fazio R, Mattei V, Al-Naami B, De Vittorio M, Visconti P. Methodologies and wearable devices to monitor biophysical parameters related to sleep dysfunctions: an overview. Micromachines. 2022;13(8):1335.

18. Karasneh RA, Al-Azzam SI, Alzoubi KH, Hawamdeh S, Jarab AS, Nusair MB. Smartphone applications for sleep tracking: rating and perceptions about behavioral change among users. Sleep Sci. 2022;15(Spec 1):65-73.