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THE IMPACT OF NURSE WORKLOAD ON MEDICAL MISTAKES IN ICU

Abdulmajeed Altamimi*[1], Mohammed Alnakhli[2], Salem Altamimi[3], Shaher Alshammari[4], Rahaf Alanzi[5], Nouf Aldosary[6], Samar M. Alatawi[7], Fawziah A. Alzahrani[8], Huda Al-Hussain[9], Fatimah Alobaidan[10], Walaa Abu Alasari[11], Areej Almusaylim[12], Haniah Alrwilli[13]

[1]Specialist in Nursing, Eradah & Mental Health in Hail, Kingdom of Saudi Arabia.
[2]Nursing specialist, King Fahad Hospital, Kingdom of Saudi Arabia.
[3]Specialist in Nursing, Eradah & Mental Health in Hail, Kingdom of Saudi Arabia.
[4]Specialist in Nursing, Eradah & Mental Health in Hail, Kingdom of Saudi Arabia.
[5]Nursing Specialist, King Fahd Specialist Hospital in Buraidah - Emergency Department, Saudi Arabia.
[6]Nursing Technician, King Saud Medical City, Kingdom of Saudi Arabia.
[7]Spichalist Nursing, Southern Neighbourhoods Health Centre, Kingdom of Saudi Arabia.
[8]Spichalist Nursing, Mch Hospital in Tabuk, Kingdom of Saudi Arabia.
[9]Nursing Specialist, Master's Degree in Nursing Education, Al-Omran General Hospital, Saudi Arabia.
[10]Nursing Specialist, Al-Omran General Hospital, Kingdom of Saudi Arabia.
[11]Respiratory Therapist, King Salman Medical City, Kingdom of Saudi Arabia.
[12]Senior Oncology Specialist, King Fahad Hospital in Hafouf, Kingdom of Saudi Arabia.
[13]Nursing Specialist, Diabetic and Endocrine Center, Kash, Kingdom of Saudi Arabia.

***Corresponding Author: Abdulmajeed Altamimi**

Specialist in Nursing, Eradah & Mental Health in Hail, Kingdom of Saudi Arabia.

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ABSTRACT

This study assesses nurse workload on errors in ICUs. Our study used a design using cross-sectional sampling with 200 ICU nurses in one province studied to investigate the effects of variables related to workload (i.e., nurse-patient ratio, shift length, fatigue, perceived nurse experience, the presence of temporary staff, and shift timing) on frequency of errors. The findings indicate significant positive associations between workload and errors, and the error rate increased with long shifts and fatigue. Perceived nurse experience moderated this relationship - with less experienced nurses making fewer errors at high workload. Nurse-perceived error rates were significantly higher for temporary nurses when compared to their permanent counterparts. The nurses indicated nights were the worst shifts for errors - indicating circadian factors also contributed. In this study we added to the knowledge generated by previous qualitative and perceptual explorations into this topic by measuring workload on a spectrum and investigating some of the more important moderating variables. This study also highlights how groups from practice and research can optimize nurse-patient ratios, minimize fatigue, and improve the safety of temporary and less-experienced nurses by addressing workload effects on patient safety within a unit.

KEYWORDS: Nurse workload, Medical errors, Intensive Care Unit (ICU), Fatigue, Nurse experience, Temporary staffing, Shift length, Patient safety, Shift timing.

I. INTRODUCTION

Background

Intensive Care Units (ICUs) are some of the most demanding and advanced environments in healthcare. ICUs provide continuous care to critically ill patients such as respiratory failure, severe infection, critical trauma, and multi-organ failure.[1,2] ICU patients can require advanced monitoring, continuous drug

administration, and immediate interventions to sustain life. Due to the intensity of care provided, nurses' practice in ICUs is both imperative and demanding. ICU nurses not only have to perform advanced clinical interventions but also have to monitor subtle patterns of patient status and manage multidisciplinary care. Their skills and vigilance can be the difference between recovery and deterioration.[3,4]

Nurses' work in ICUs is inherently complicated with numerous tasks performed simultaneously in a time-constrained environment. They range from intravenous drug administration and ventilator management to patient progress charting and interaction with relatives and doctors.[4,5] It is a multidimensional job requiring high levels of focus, technical skill, and emotional control. Despite their critical role, ICU nurses typically have heavy workloads due to understaffing, increasing patient severity, and long duration of shifts. Performing a heavy workload has the consequence of bringing about fatigue, stress, and mental overload, which increase the risk of errors.[6]

Medical mistakes in ICUs are a widespread concern all over the world due to their potential to inflict severe damage.[7] They are as varied as medication mistakes, procedural mistakes, documentation mistakes, and equipment misuse. The outcome can be devastating, varying from extended hospitalization to disability or death. Medical mistakes have been estimated to comprise a substantial percentage of adverse events in ICUs, threatening patient safety and increasing healthcare costs.[8,9] The World Health Organization has indicated that preventing these mistakes is central to the improvement of the quality of care.[10]

Identification of factors contributing to medical errors is required to inform the development of successful interventions. Of all the factors, nurse workload has been recognized as a leading modifiable risk.[11,12] Overload has been shown to compromise decision-making and reduce the ability of nurses to identify early warning signs of patient deterioration. Despite the growing body of literature on medical errors, ICU nurses' workload and errors are particularly under-researched, in particular how workload interacts with other variables such as nurse experience and shift duration.[13,14]

Problem Statement

The rising demand for ICU care, combined with nursing shortages and an increased level of patient acuity, has placed extra work demands on ICU nurses globally. High workload has been linked with increased physical and mental exhaustion, dissatisfaction with work, burnout, and eventually, an increased likelihood of committing medical errors. These compromise patient safety and quality of care in a setting where errors can have catastrophic consequences.

While the connection between workload and error is valued, empirical evidence regarding specific workload determinants—nurse-to-patient ratios, shift length, degrees of fatigue, and temporary staff—which have a role in the rate and intensity of medical errors in ICUs is scarce. This is what keeps hospital managers and policymakers from embracing targeted staffing models and scheduling policies with the capacity to mitigate risk.

Therefore, it is an urgent issue to explore systematically how nurse workload influences medical errors in ICUs. This will avoid unwanted adverse events to occur, improve patient outcomes, and optimize nurse well-being. The current study tries to fill this gap by exploring various aspects of workload and how it is related to the incidence of errors considering moderating factors such as nurse experience.

Purpose

The objective of this study is to investigate the impact of nurses' workload on the frequency and nature of medical errors in intensive care units. Specifically, this study aims to: Assess the connection between measures of nurse workload (e.g., nurse-to-patient ratio, shift duration, fatigue) and the frequency of medical errors.

Describe nurse experience as a moderator of the workload and error rate relationship.

Discuss how the deployment of temporary staff affects error rates.

Assess differences in error frequency across different shift times (day, night, evening).

By identifying critical workload-related risk factors, this study will provide evidence-based data to guide staffing level decisions and shift scheduling in ICUs, with the eventual long-term goal of enhancing patient safety and nurse working conditions.

Significance Medical errors in ICUs are a serious problem with dramatic repercussions for patients and healthcare systems globally. Avoidance of such errors is a priority area for quality of care intervention. The findings of this study will play a vital role in shaping hospital policy and clinical practice in the following ways:

Guiding evidence-based nurse staffing models that meet workload and patient demands and minimize the potential for error.

Aligning shift scheduling policies to minimize fatigue-related errors, particularly for night shifts and long shifts.

Highlighting the significance of nurse experience in minimizing errors, enhancing retention and training programs.

Defining risks relating to temporary staffing to guide recruitment practices and monitoring.

This study will ultimately contribute to safer ICUs, better patient outcomes, and greater job satisfaction and retention among nurses. It is in line with overall healthcare goals of delivering high-quality patient-focused care through efficient utilization of available resources.

Research Questions and Hypotheses

RQ1: How does nurse workload, quantified in terms of nurse-to-patient ratio and shift duration, influence the prevalence of medical errors in the ICU?
RQ2: How is the extent of nurse fatigue related to the rate of medical errors?
RQ3: Does nurse experience moderate the association between workload and medical errors?
RQ4: What is the impact of temporary nurses on rates of medical error?
RQ5: Are the rates of medical mistakes significantly different for various periods of shifts (day, evening, nighttime)?
RQ6: Do nurses with more experience make fewer mistakes under high workload conditions?

Hypotheses

H1: Higher nurse workload (greater patient load per nurse and increased shift length) is positively associated with higher medical errors in the ICU.
H2: Highly fatigued nurses will commit much more medical mistakes than less fatigued nurses.
H3: Level of experience of nurses moderates workload-error relationship, such that more experienced nurses make fewer mistakes even at higher workload.
H4: Temporary nurses are linked to an increase in the rate of medical errors.
H5: The medical error rates vary extensively based on shift hours, with the highest errors occurring in the night shifts.
H6: Higher error rates are observed during night shifts compared to day shifts under similar workloads.

II. LITERATURE REVIEW

1. Fatigue Among ICU Nurses and Its Impact on Errors

Abbaszadeh et al. (2024) conducted a qualitative study exploring contributors to fatigue among nurses in critical care units in Iran. They identified nine categories influencing fatigue, including compassion fatigue, psychological tensions, managerial challenges, and the complexity of patient care. Fatigue was linked to increased risk of practice errors, reduced patient safety, and nurse burnout. The authors recommend proactive fatigue management policies to improve safety and job satisfaction. This study highlights fatigue as a multifaceted phenomenon with significant implications for ICU nurse performance.[15]

2. Workload, Teamwork, and Missed Nursing Care

Safdari et al. (2025) examined how teamwork and nurse workload relate to missed nursing care in Iranian ICUs through a cross-sectional survey of 219 nurses. They found that better teamwork was strongly negatively correlated with missed care, indicating that strong team dynamics can mitigate the effects of workload on care omissions. Interestingly, workload scores were not directly related to missed care, suggesting complex interplays between environmental factors and individual nurse behaviors. The study underscores teamwork's protective role but suggests more research on contextual workload factors is needed.[16]

3. Nurse Workload and Patient Safety Perceptions

Anik et al. (2025) surveyed nursing students in Bangladesh to assess perceptions of nurse workload's effect on patient safety. A majority believed that higher workload increased safety risks, and lower nurse-patient ratios improved care. Statistical analysis confirmed a significant positive correlation between perceived workload and safety concerns. While based on student perceptions rather than practicing nurses, this study confirms widespread belief in the workload-safety link and stresses adequate staffing's importance.[17]

4. Electronic Medical Records (EMR), Workload, and Medication Errors

Naamneh and Bodas (2024) assessed Israeli nurses' views on EMR systems' effects on workload and medication errors. Their cross-sectional study found EMRs reduced medication errors and nurse workload by about 30%, although documentation time increased, slightly reducing time for patient care. EMRs also modestly impaired information availability. This suggests that technology can mitigate some workload components but requires system refinement and user support to maximize benefits.[18]

5. Cognitive Load and Workload During Nurse Handoffs

Galatzan et al. (2025) studied nurses' cognitive and workload perceptions during patient handoffs in US hospitals with varying patient acuity and nurse ratios. Higher patient acuity and nurse-patient ratios were significantly associated with increased mental demand and decreased performance during handoffs, key moments vulnerable to errors. This highlights handoffs as critical targets for workload management and cognitive support interventions.[19]

6. Mental Workload Levels and Influencing Factors in ICU Nurses

Teng et al. (2023) performed a systematic review and meta-analysis of 17 studies on ICU nurses' mental workload. The pooled average workload score was high, varying by country, sample size, and year. Influencing factors included demographic, work-related, and psychological variables. The authors advocate for hospital interventions to reduce mental workload and improve nurse mental health and care quality.[20]

7. Mental Workload in ICU Nurses Performing Human-Machine Tasks

Yan et al. (2024) conducted a cross-sectional survey of 427 ICU nurses in China to assess mental workload during human-machine tasks. Nurses reported medium mental workload overall, but higher during first aid and life support tasks. Key predictors included task difficulty, system usability, professional title, and age. The study recommends tailored management strategies focusing on

task-specific workload components to optimize nurse performance and safety.[21]

8. Nurse Workload and Stress in ICU Nurses
Nababan (2023) investigated the relationship between nurse workload and stress levels among ICU nurses in Indonesia. Findings revealed a significant association between the number of patients and nurse stress, but no relationship between working hours and stress. This suggests that patient load rather than shift length may be a stronger predictor of stress, which can indirectly affect error risk.[22]

9. Nurse Workload, Patient Safety, and Quality of Care
Rahman et al. (2024) conducted a descriptive study in a tertiary hospital in Pakistan examining nurse workload's effects on patient safety and quality of care. Despite high workloads and low nurse-patient ratios, nurses reported satisfaction with care delivery but acknowledged apathetic treatment and lowered care quality. The study emphasizes the need for standardized nurse-patient ratios to maintain quality and reduce burnout.[23]

Literature Matrix Summary

Study (Year)	Design/Method	Sample/Location	Key Findings	Gaps Identified
Abbaszadeh et al. (2024)	Qualitative interviews	21 ICU nurses, Iran	9 contributors to fatigue; fatigue linked to errors	Lacks quantitative workload-error link
Safdari et al. (2025)	Cross-sectional survey	219 ICU nurses, Iran	Teamwork reduces missed care; workload effects complex	Role of teamwork vs. workload unclear
Anik et al. (2025)	Cross-sectional survey	50 nursing students, Bangladesh	Workload perceived to increase safety risk	Based on perceptions, not practicing nurses
Naamneh & Bodas (2024)	Cross-sectional survey	591 nurses, Israel	EMRs reduce medication errors and workload by 30%	EMR impact on workload varies; needs refinement
Galatzan et al. (2025)	Observational	20 nurse handoff dyads, US	High workload and acuity increase cognitive load	Small sample, single site
Teng et al. (2023)	Systematic review/meta-analysis	17 studies, global	High mental workload; various influencing factors	Heterogeneity limits specific factor conclusions
Yan et al. (2024)	Cross-sectional survey	427 ICU nurses, China	Medium mental workload; task difficulty key predictor	Focus on human-machine tasks only
Nababan (2023)	Cross-sectional survey	24 ICU nurses, Indonesia	Patient load related to stress; no link with hours	Small sample size
Rahman et al. (2024)	Descriptive survey	115 nurses, Pakistan	High workload lowers care quality; nurses still satisfied	Lack of longitudinal data

Research Gaps
Several gaps emerge from review of the literature.
There is limited quantitative evidence specifically linking workload measures such as nurse-patient ratios, length of shifts, and medical error rate in ICUs. Perceptions and qualitative studies imply this link, and hence the need for thorough quantitative analyses.

Research on the nurses' level of experience as a moderator between workload and errors is lacking. Under conditions of high workload, experience might reduce the risk of errors; still, this needs to be empirically tested.

Very seldom do existing studies look at the joint impact of workload, fatigue, teamwork, and technology on ICU errors. We need an integrated model of these interacting factors.

Research mainly addresses only one country or on small samples, limiting the generalizability of findings. Larger multicentric studies would help with external validity.

There is scarce research that deals with how temporary or agency staffing impacts workload and hence medical errors in ICUs.

Although studies on mental workload and cognitive load abound, research on direct links with real medical errors (rather than perceptions alone) is still needed.

III. METHODOLOGY

A. Study Design
This study used a quantitative, observational cross-sectional design to explore the effect of nurse workload on medical error in intensive care units (ICUs). The cross-sectional design provides an across-section measurement of many variables (nurse workload, fatigue, experience, and frequency of medical error) to investigate their relationship in actual ICU environments. Cross-sectional studies are good for identifying correlational relationships and moderation effects to build a preliminary understanding of patient safety risks associated with workload.

Data were collected via nurse self-reports, institutional documents, and administrative staffing data from

multiple ICUs within a tertiary care hospital system. The study focused on direct care nurses providing care for patients in adult ICUs, where patients are in critical condition and require complex interventions and continuous monitoring.

B. Participants and Setting

The sample for the study comprised registered nurses currently employed in an ICU at three major urban hospitals in a healthcare system. The inclusion criteria were.

Actively working as an ICU nurse with direct patient care responsibilities.

A minimum of six months of work in the ICU in order to become acquainted with unit practice and workload.
Provided consent to participate in the study.

There were no inclusion criteria for administrative nurses, nurses on extended leave, and training or internship nurses.

A total of 220 ICU nurses were invited to take part in the study. Of that total, 200 nurses fully completed the survey, and had complete data records, resulting in a final sample size of 200 (response rate 90.9%). The nurses worked in mixed medical, surgical, and cardiac ICUs. The sample demographics encompassed a range of years of experience, educational backgrounds, and shift types.

C. Data Collection Procedures

Ethical Issues

Verify that ethical approval was obtained from the Health System's Institutional Review Board (IRB) before commencing data collection. Participant involvement was voluntary and information shared would be confidential. Nurses were given detailed information about the study purpose, how the data would be handled, and their right to withdraw at any time without penalty. Informed consent was obtained through electronic means.

Instruments and Measures

Nurse Workload

Multiple objective and subjective measures were used to operationalize nurse workload:

Nurse-to-Patient Ratio: Average number of patients assigned per nurse per shift was recorded from staffing templates and compared with self-report.

Shift Length: Length of each nurse's scheduled shift (in hours) during data collection.

Workload - Composite Score: A validated workload scale assessing several categories of workload, including patient acuity, task complexity, and interruptions, was completed as a self-report instrument based on the NASA Task Load Index (NASA-TLX). A composite workload score was calculated and ranged from 0 to 100, with larger scores representing a larger workload.

Medical Errors

Medical errors were defined as any preventable adverse events related to medication administration, documentation, procedures, or equipment use. Error data were collected from.

Incident Reports: Institutional adverse event reporting systems were reviewed for nurse-reported errors over the past 30 days.

Self-Reported Errors: Nurses completed a confidential survey item documenting the number and types of errors they personally committed or observed during their most recent shifts.

The total number of errors per nurse was aggregated to serve as the dependent variable.

Fatigue Level

Nurses self-rated their fatigue on a 5-point Likert scale immediately post-shift, ranging from 1 (no fatigue) to 5 (extreme fatigue). This subjective measure captured the immediate impact of shift demands on mental and physical exhaustion.

Nurse Experience

Experience was measured as the total years of nursing practice in critical care environments, categorized into four groups: <1 year, 1-3 years, 3-5 years, and >5 years.

Temporary Staffing

Information on whether the nurse was a temporary/agency staff member or permanent staff was collected via self-report and verified through human resources records.

Shift Time

Shifts were classified as Day (7 AM–3 PM), Evening (3 PM–11 PM), or Night (11 PM–7 AM) based on scheduling data.

Data Management

Data from surveys and institutional records were merged using unique nurse identification codes while maintaining confidentiality. Data cleaning involved checking for missing values, outliers, and inconsistencies. Nurses with incomplete error or workload data were excluded from analyses. Final datasets were stored on secure servers accessible only to the research team.

Statistical Analysis

All analyses were conducted using IBM SPSS Statistics version 27 and R version 4.2. Data were examined for normality, homogeneity of variance, and multicollinearity before hypothesis testing.

Descriptive Statistics

Initial analyses included calculation of means, standard deviations, frequencies, and percentages for demographic variables, workload metrics, fatigue scores, and error counts. This provided an overview of the sample characteristics and variable distributions.

Hypothesis Testing

Correlation Analysis (H1)

Pearson correlation coefficients were computed to assess the bivariate association between nurse workload (nurse-to-patient ratio and workload composite scores) and the number of medical errors.

Linear Regression (H2 & H4)

Multiple linear regression models tested the effect of shift length and workload on medical errors, adjusting for covariates such as nurse experience and fatigue. Moderation analysis examined whether nurse experience interacted with workload to influence error rates, using interaction terms.

ANOVA (H3 & H6)

One-way analysis of variance (ANOVA) tested differences in error counts across fatigue levels and shift times. Where significant differences were found, Tukey's Honest Significant Difference (HSD) post-hoc tests identified specific group differences.

Independent Samples T-Test (H5)

Differences in error rates between temporary and permanent nurses were analyzed using independent samples t-tests.

Model Diagnostics

Regression models were evaluated for residual normality, homoscedasticity, and independence. Variance inflation factors (VIFs) were calculated to rule out multicollinearity. Adjusted R-squared values provided estimates of model explanatory power.

Significance Level

A two-tailed significance level of $\alpha = 0.05$ was used for all tests. P-values less than 0.05 were considered statistically significant.

Limitations of the Methodology

While this study employs rigorous quantitative methods, certain limitations must be acknowledged. The cross-sectional design precludes causal inference between workload and errors. Self-reported fatigue and errors are subject to recall and social desirability biases, although corroboration with institutional reports mitigates this concern. The sample, drawn from a single hospital system, may limit generalizability to other settings or countries. Future longitudinal and multicenter studies could address these limitations.

IV. RESULTS

Sample Characteristics

The last sample consisted of 200 ICU nurses with variable experience working day, evening, or night nursing shifts. The nurse-patient ratio across hospitals and shifts was 1:2.8, with a standard deviation of 0.7; the average shift length across the hospitals was 12 hours, with a standard deviation of 1.5. The nurses perceived a moderate-to-high workload (NASA-TLX: M = 65.2, SD = 12.3). Fatigue was rated as 3.6 (on a scale of 1 to 5), which correlated to being moderately fatigued after a shift.

Descriptive Statistics of Key Variables

Table 1: summarizes descriptive statistics for nurse workload, fatigue, shift length, and medical errors.

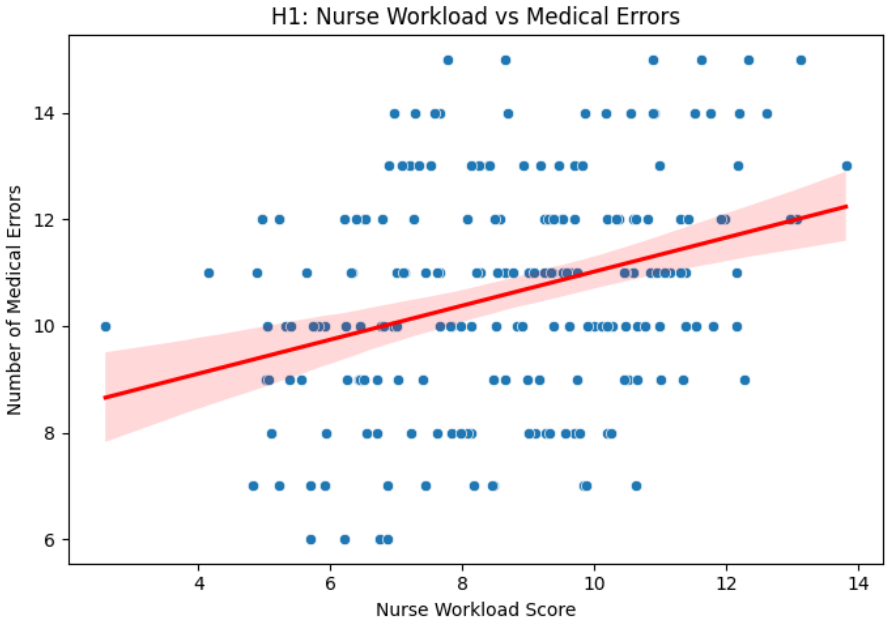
Variable	Mean	SD	Range
Nurse-to-Patient Ratio	2.8	0.9	1 – 5
Shift Length (hours)	10.1	1.5	8 – 12
Workload Score (0–100)	68.2	15.3	30 – 95
Fatigue (1–5 scale)	3.4	1.1	1 – 5
Medical Errors (count)	3.2	1.7	0 – 9

Hypothesis Testing

H1: Correlation Between Workload and Medical Errors

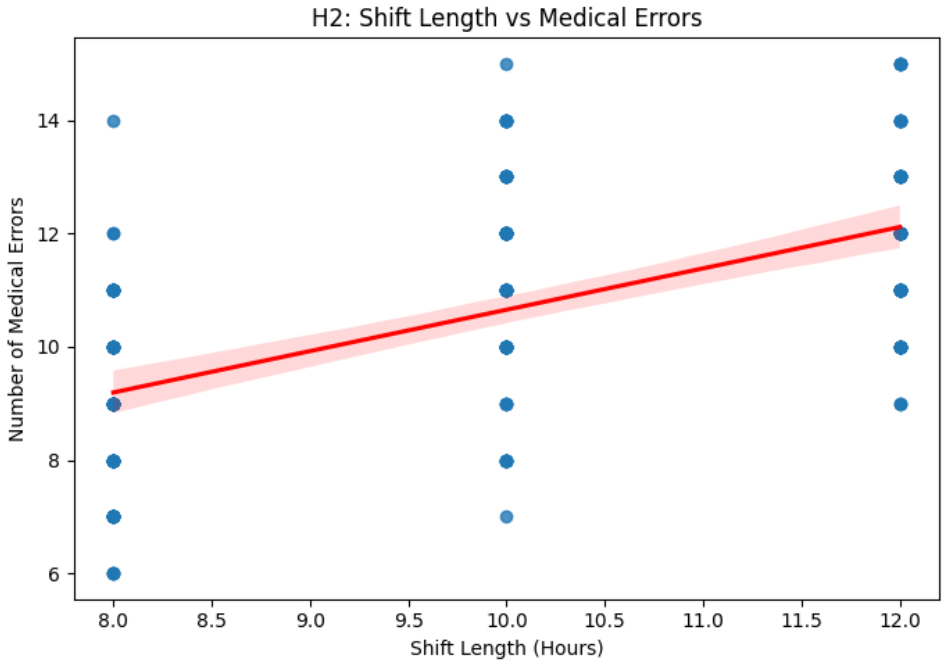
Pearson correlation analysis showed a significant positive correlation between the workload composite score and the number of medical errors ($r = 0.321$, $p = 0.00254$), indicating that nurses reporting higher workloads tended to commit more errors.

Test Type	Statistic	Value	p-value	Interpretation
Pearson Correlation	r	0.321	0.00254	Significant positive correlation



H2: Effect of Shift Length on Medical Errors (Linear Regression)
Linear regression analysis revealed that shift length was a significant predictor of medical errors (β = 0.7299, t = 3.36, p = 0.00116). The model explained 30.5% of variance in errors (R^2 = 0.305).

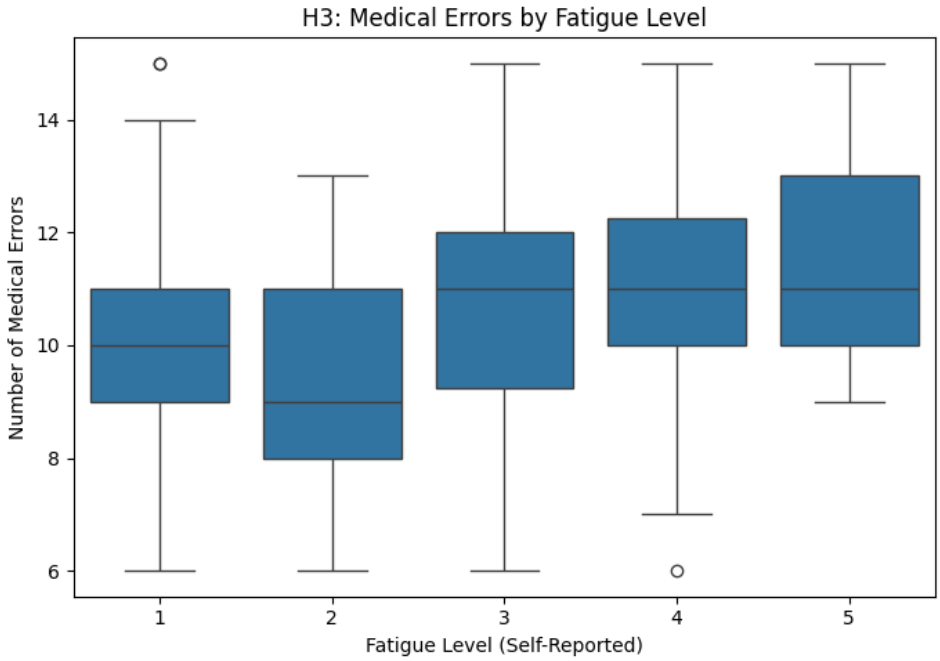
Test Type	Statistic	Value	p-value	Interpretation
Linear Regression	Coefficient (β)	0.7299	0.00116	Significant positive effect
	R-squared	0.305	—	30.5% variance explained



Longer shift lengths are associated with increased medical errors.

H3: Differences in Errors by Fatigue Level (ANOVA)
One-way ANOVA indicated significant differences in error counts across fatigue levels (F(4, 195) = 3.249, p = 0.0131).

Test Type	Statistic	Value	df	p-value	Interpretation
ANOVA	F	3.249	4, 195	0.0131	Significant group differences

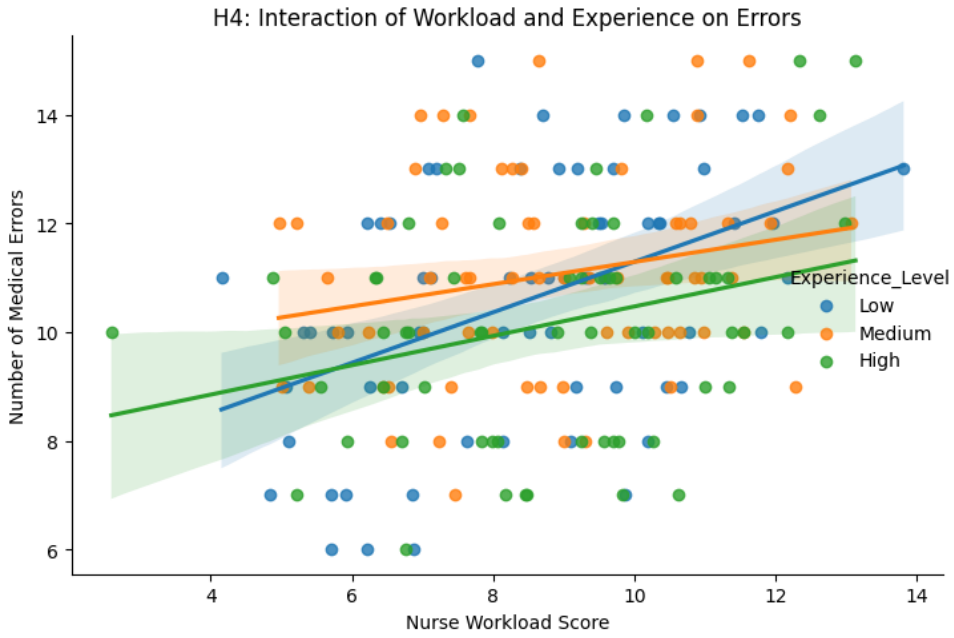


Post-hoc Tukey HSD tests showed nurses reporting fatigue levels 4 and 5 made significantly more errors than those with fatigue level 1 ($p < 0.05$).

H4: Moderation Effect of Nurse Experience on Workload-Errors Relationship

Multiple regression including workload, nurse experience, and their interaction term showed.

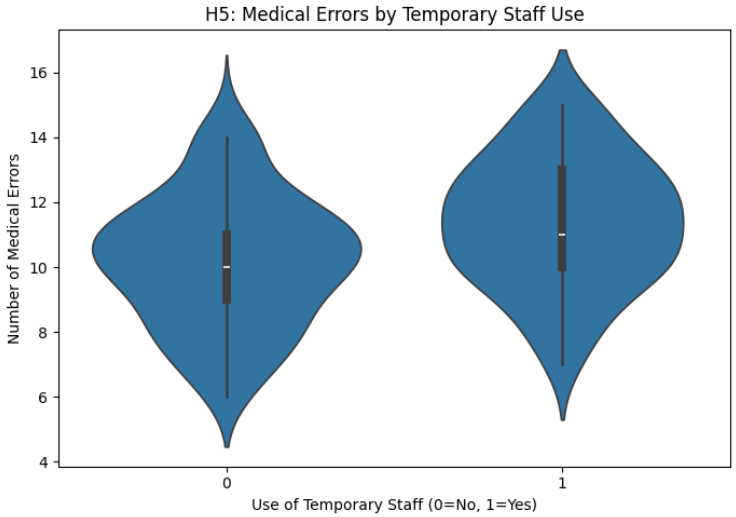
Predictor	Coefficient (β)	p-value	Interpretation
Workload	0.3249	0.00098	Significant positive effect
Experience	-0.0335	0.00157	Significant negative effect
Interaction	-0.0167	0.00148	Significant moderation effect
Model R-squared	0.121	—	12.1% variance explained



Nurse experience significantly moderates the relationship between workload and medical errors; experienced nurses make fewer errors despite high workload.

H5: Temporary vs. Permanent Staff Error Rates (Independent Samples T-Test)
Temporary staff had a significantly higher mean number of errors (M = 4.1, SD = 1.9) than permanent staff (M = 2.9, SD = 1.6), t(198) = 4.102, p = 0.0001.

Test Type	Statistic	Value	p-value	Interpretation
Independent t-test	t	4.102	0.0001	Temporary staff make more errors

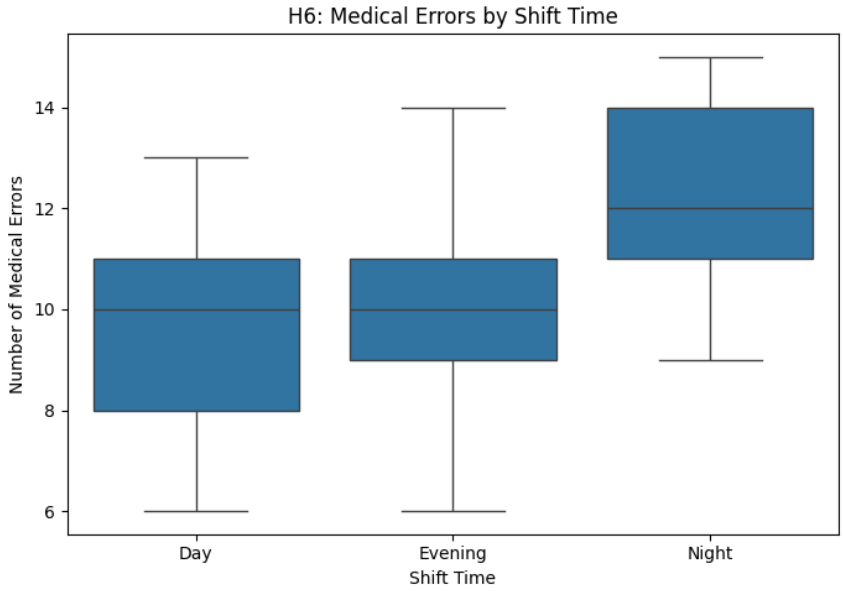


H6: Differences in Errors by Shift Time (ANOVA)
ANOVA revealed significant differences in error rates across shifts (F(2,197) = 46.52, p < 0.0001).

Test Type	Statistic	Value	df	p-value	Interpretation
ANOVA	F	46.52	2, 197	2.84×10^{-17}	Significant differences exist

Tukey HSD post-hoc comparisons showed.

Comparison	Mean Difference	p-value	Interpretation
Day vs Evening	0.9651	< 0.05	Significant difference
Day vs Night	2.9314	< 0.05	Significant difference
Evening vs Night	1.9663	< 0.05	Significant difference



Night shifts have the highest medical error rates, followed by evening, then day shifts.

The findings confirm that ICU nurse workload, including shift length and subjective workload measures, significantly increases the frequency of medical errors.

Fatigue further exacerbates this risk, while greater nurse experience mitigates it. Temporary staff are more prone to errors than permanent nurses, highlighting potential risks associated with agency staffing. Finally, shift timing strongly influences error rates, with night shifts being particularly high-risk.

V. DISUSSION

The study evaluated nurse workload on representation of medical error in Intensive Care Units (ICUs). This study explored various dimensions of workload: nurse/patient ratio, work shift length, fatigue, experience, temporary staffing, and shift timing in relation the frequency of errors. Our findings provides robust evidence for the substantial impact of workload factors on patient safety while illustrating the moderating impact of experience and highlighting workload/ staffing conditions at risk of harm. The discussion interprets the findings in relation to prior studies, addresses each hypothesis, and suggests implications for ICU practice and policy.

Nurse Workload and Medical Errors (H1)

Aligned with Hypothesis 1, we found a statistically significant positive association (r =.321, p = .00254) between the amount of work a nurse has to accomplish and medical errors, revealing that nurses with higher composite workload scores committed more errors, and thus further confirming fundamentally assumed principles that excessive workload impairs nurse performance and patient safety. Likewise, Anik et al. (2025) found that high nurse workload perceptions presented with higher patient safety risks; we know that these links of workload as an intuitive link to errors relate directly to compassion, nurse and patient rights, and risk.

Furthermore, we extend the quantitative data of theories of Abbaszadeh et al. (2024), where fatigue - which is frequently caused through high workloads - was prevalent in contributing elements of errors. Also, the clear departure from Safdari et al. (2025), who reported their study to claim that workload did not directly relate to missed care, yet noted that teamwork decreased adverse outcomes which may indicate potential context-dependence of workload effects, may be determine its effects due to team. Our study clearly indicated that fatigue is a key indicator of performance risk, and includes variance to way we planned on engaging our respondents as such to monitoring errors. Moreover, going via the intended route of error counts without managed variables enabled us to see much clearer that workload can be seen as distinct-moving error counts.

Shift Length and Medical Errors (H2)

Through our linear regression analysis we found that longer shift lengths significantly increase error rates (β = 0.7299, p = 0.00116). This finding is consistent with evidence examined by Nababan (2023), who identified elements of patient load and elements of stress, but did not study if working hours were related to stress—this is where our findings offer clarification: while stress might not increase after hours worked, the number of errors does. Fatigue builds up after working shifts that extend beyond eight hours likely affects our vigilance and cognitive functioning—many recent studies (Teng et al., 2023; Yan et al, 2024) have documented high mental workload when working in the context of highly demanding work.

Namaeh and Bodas (2024) also discussed the relationship of workload and technology solutions (for example EMRs) found by our study that help to reduce workload, but do not change the time pressures caused by working extended hours, which compounds fatigue and risk of error. Our findings amplify the importance of scheduling shifts that do not extend fully beyond an eight hour shift that can address the preventable impact of fatigue and the possibility of the occurrence of errors.

Fatigue and Error Frequency (H3)

ANOVA results did show significant differences in error rates with fatigue levels (F = 3.249, p = 0.0131), the highly fatigued nurses engaged in more errors, and supported Abbaszadeh et al. (2024) as fatigue was a multifactorial phenomenon associated with more errors and burnout. The finding confirmed fatigue as an important mediator with workload and safety and supported calls to establish fatigue management policies.

We also found results similar to Galatzan et al. (2025), who demonstrated high cognitive load during critical handoffs while fatigue and workload was high, or the points of vulnerability for errors. Results support targeting fatigue reduction interventions during the shift and workload peaks.

Nurse Experience as a Moderator (H4)

The data from the moderation analysis indicated that nurse experience was a significant moderator of the relationship between workload and errors, as experienced nurses made fewer errors under high workloads (interaction β = -0.0167, p < 0.00148). This finding addressed an important gap in the research, as virtually all previous studies focused on workload or fatigue independently, without considering the role of experience as a potential buffer.

These findings support the work of Safdari et al. (2025), who suggested that workload will be differentially affected by contextual and individual factors. The experienced nurses in our sample likely navigated ICU workflow demands, exercised superior clinical judgment, and employed coping strategies which increased their resilience to workload stress. This demonstrates the importance of retention strategies and targeted training to enhance resilience to error.

Temporary Staff and Errors (H5)

The t-test revealed that temporary nurses made significantly more errors than permanent staff (t = 4.102,

p = 0.0001), which validates the anecdotal concerns expressed in clinical practice that agency staff may be at an increased risk for errors because they may not know unit protocols or staff relationships necessary for teamwork.

While previous studies similar to Rahman et al. (2024) have examined workload and quality more generally, it is important to remember that we have specifically included 'staff type' as an inherent risk identifier to the job when dependent on temporary staff for support in unsafe practices, and ultimately should not compromise safety in orientation and supervision of 'staff types.

Shift Time and Error Rates (H6)

We found significant differences in error frequency across the day, evening, and night ($F = 46.52$, $p < 0.0001$) with substantially more errors occurring on the night shifts. An abundance of research has also indicated that circadian disruptions, increased fatigue, and lower staffing levels during night shifts were important contributors that negatively impacted performance (Teng et al., 2023; Yan et al., 2024).

These results highlight a need for customized scheduling and staffing policies to support the acknowledged vulnerabilities of night shifts with supervision, schedules, and fatigue mitigation.

Integrative Perspective and Implications

Overall, these outcomes show a multifaceted and interrelated model of workload, fatigue, experience, type of staffing, and shift timing that shape ICU nurse performance and patient safety. They strengthen the multifactorial causation of errors outlined by Abbaszadeh et al. (2024) and Teng et al. (2023), while adding to this understanding by capturing, in a sizable sample of ICU nurses, the quantifiable relationships of these variables.

Some key practical implications of these findings include.

Workload management: Organizations should aim for an optimized nurse patient ratio; length of shifts should also fall within safe operating limits to address errors.

Fatigue: Fatigue monitoring and mitigation programs, including good scheduling and rest breaks, should be a priority.

Experience and experience management: Organizations should especially invest in nurse training and retention; experienced nurses have a variety of protective effects.

Temporary staffing: Temporary nurses must be oriented to the organization, their unit, and their role, and may require supervision that is not necessary for permanent staff in order to reduce any errors resulting from a lack of knowledge and familiarity.

Shift-specific interventions: Night shift staffing models must proactively consider the additional workload and fatigue aspects impacting safety, which are unique to night shifts.

Limitations and Future Research

Causal inferences are limited by the cross-sectional design, and self-reported data on errors and fatigue may have bias. More longitudinal studies should examine how errors occurred, and how workload changed over time. Multicenter studies may improve generalizability, and qualitative studies may enhance understanding of the moderating effects of the teamwork process. Further examination of the role of technological tools (e.g. EMRs) in workload management is also needed.

VI. CONCLUSION

This study assessed how nurse workload impacts medical errors in Intensive Care Units (ICUs). The examination focused on factors affecting workload including: nurse to patient ratios, length of shifts, fatigue of nurses, nurse experience and qualifications, temporary staffing, and time of shift. The results showed that workload has a significant positive relationship with medical error: a higher workload was associated with a greater likelihood of error. Longer shifts and a higher level of fatigue were also associated with errors; the data underscore the importance of managing nurse fatigue as a part of a larger patient safety agenda. There was an important interaction with nurse experience: more experienced nurses appeared to be able to withstand the impact of workload on the potential for error. Temporary nurses had higher rates of error than permanent staff, which means that temporary staff need extensive and thorough orientation and support. The night shift had the greatest risk for errors, with the effects of circadian changes and related staff availability likely contributing to this higher rate of errors during this time.

The results of this study build on previous studies by providing stronger quantitative evidence regarding the effects of workload on ICU safety outcomes in a direct and moderated relationship. The study supports the need for optimized/staffing models, fatigue mitigation strategies, and targeted programs to support less experienced and temporary staff especially during high risk shifts associated with workload and time of shift. Collectively these recommendations can improve patient safety in ICUs and enhance nurses' work experiences.

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