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Contributing human factors to nursing errors in intensive care therapy

Fatores humanos contribuintes para o erro em enfermagem na terapia intensiva

Factores humanos que contribuyen a los errores de enfermería en cuidados intensivos

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ABSTRACT

Objective: to analyze human factors contributing to errors within the nursing work process in intensive care. **Method:** descriptive, cross-sectional, qualitative study conducted in the Intensive Care Unit of a public, federal general hospital. Data were collected between December 2022 and April 2023 through semi-structured interviews and subjected to lexicometric analysis using the IRAMUTEQ software. **Results:** the study included 25 nursing professionals, consisting of nine nurses and 16 nursing technicians. Corpus utilization was 85%. Human factors related to organizational influences, such as human and material resource management, organizational climate, and operational processes, directly contributed to unsafe acts committed by nursing professionals, resulting in errors and violations. **Conclusion:** recognizing human factors is essential for strengthening a safety culture, increasing organizational reliability, and improving healthcare quality and safety.
Descriptors: Brain Death; Tissue and Organ Procurement; Health Personnel; Family; User Embracement.

RESUMO

Objetivo: analisar os fatores humanos contribuintes para o erro no processo de trabalho de enfermagem na terapia intensiva. **Método:** estudo descritivo, transversal, qualitativo, tendo como cenário o Centro de Terapia Intensiva de um hospital geral, público e federal. Os dados foram coletados entre dezembro de 2022 e abril de 2023, por meio de entrevistas semiestruturadas e submetidos à análise lexicométrica com auxílio do software IRAMUTEQ. **Resultados:** participaram do estudo 25 profissionais de enfermagem, sendo nove enfermeiros e 16 técnicos de enfermagem. O aproveitamento do *corpus* foi de 85%. Fatores humanos relacionados as influências organizacionais, como gestão de recursos humanos e materiais, clima organizacional e processo organizacional, contribuem diretamente para os atos inseguros cometidos pelos profissionais de enfermagem, culminando em erros e violações. **Conclusão:** o reconhecimento dos fatores humanos é crucial para o fortalecimento da cultura de segurança, aumento da confiabilidade organizacional, e para melhorias na qualidade e segurança em saúde.
Descritores: Morte Encefálica; Obtenção de Tecidos e Órgãos; Profissionais de Saúde; Família; Acolhimento.

RESUMEN

Objetivo: analizar los factores humanos que contribuyen a los errores en el proceso de trabajo de enfermería en cuidados intensivos. **Método:** estudio descriptivo, transversal, cualitativo, desarrollado en una Unidad de Cuidados Intensivos de un hospital general, público y federal. Los datos fueron recolectados entre diciembre de 2022 y abril de 2023, mediante entrevistas semiestructuradas y sometidos a análisis lexicométrico con el soporte del *software* IRaMuTEQ. **Resultados:** participaron en el estudio 25 profesionales de enfermería, constituidos por 9 enfermeros y 16 técnicos de enfermería. El aprovechamiento *del corpus* fue del 85%. Los factores humanos relacionados con las influencias organizacionales, como la gestión de recursos humanos y materiales, el clima organizacional y los procesos organizacionales, contribuyen directamente a los actos inseguros cometidos por los profesionales de enfermería, que culminan en errores y violaciones. **Conclusión:** el reconocimiento de los factores humanos es fundamental para fortalecer la cultura de seguridad, aumentar la confiabilidad organizacional y mejorar la calidad y la seguridad en materia de salud.
Descriptores: Muerte Encefálica; Obtención de Tejidos y Órganos; Personal de Salud; Familia; Acogimiento.

INTRODUCTION

Human factors are defined as the ways in which individuals interact with the systems in which they operate. This concept involves the study of multiple disciplines, including anatomy, physiology, physics, and biomechanics, with the aim of understanding human performance across different contexts and identifying elements that facilitate optimal task execution[1,2]. Considering the human contribution to safety and the complexity of organizational defense systems, human factors play a critical role in both the causation and prevention of accidents[3], often resulting in adverse healthcare events.

Based on the relationship between human factors and organizational accidents described by Human Error Theory[3], the Human Factors Analysis and Classification System (HFACS) was developed to investigate and analyze the human

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contribution to the occurrence of incidents, errors, and adverse events[4]. HFACS classifies contributing human factors into four hierarchical levels: unsafe acts, preconditions for unsafe acts, unsafe supervision, and organizational influences. These levels reflect individual, environmental, leadership, and organizational dimensions[5].

Understanding human factors is essential for developing resilient and high-reliability healthcare services that are capable of maintaining a constant state of safe operation, recovering quickly, and restoring safe conditions when errors are identified. High-reliability organizations are able to anticipate problems, use data to monitor processes and working conditions, respond to early warning signs, and consistently learn from both successes and failures[2].

Healthcare services are inherently vulnerable to errors and adverse events. It is estimated that approximately 10% of patients experience at least one adverse event throughout their lives[6]. In the United States, more than 250,000 patients receiving healthcare each year will experience an adverse event, and over 100,000 will die as a result of the care they received[7]. In Brazil, one study found that the incidence of healthcare-related adverse events was 33.7%, with an incidence density of 4.97 adverse events per 100 patients[8].

In this context, it is important to highlight the nursing work process, which encompasses five dimensions that may occur simultaneously or independently: care provision, management, teaching, research, and political participation[9]. This process involves all professionals that constitute the nursing team, in accordance with the professional practice regulated by the Federal Nursing Council under Law No. 7.498 of June 25, 1985. This regulation defines the exclusive responsibilities of nurses as well as the duties of other nursing professionals, including nursing technicians, nursing assistants, and midwives.

The nursing work process involves a variety of human factors that are subject to intervention. These include individual actions such as skill execution, awareness, distraction, and decision-making, as well as the working conditions, including stress, fatigue, inadequate physical environments, leadership styles, misinterpretation of safety culture, poor communication, and weak teamwork[10]. Such factors are particularly prevalent in high-complexity hospital settings like the Intensive Care Unit (ICU).

Within the ICU, the nursing work process is highly complex due to the critical condition of patients, who are often vulnerable and highly dependent. This scenario demands focused care management, constant professional vigilance, rapid decision-making, effective teamwork, and intense physical and mental workload, along with exposure to occupational hazards. Nursing professionals in these units are subject to various stressors that can lead to cognitive failures, which may result in errors and adverse events.

Because they provide continuous care, ICU nursing professionals are considered the “front line” of the healthcare system and are therefore more likely to commit errors. Nursing errors in ICUs may include medication mistakes, failure to raise bed rails, loss of catheters, tubes, and drains, improper use of personal protective equipment (PPE), inadequate hand hygiene, and incorrect handling of medical devices[11]. Although often attributed to individuals, these errors primarily serve as triggers for latent organizational safety issues and may result in severe patient harm[12].

Given that ICU nursing professionals are exposed to human factors that may contribute to errors and adverse events, which in turn affect nursing care and patient safety, this study aimed to analyze human factors contributing to errors within the nursing work process in intensive care units.

METHOD

This is a cross-sectional, descriptive study with a qualitative approach, based on Human Error Theory[13] as the theoretical-methodological framework and the HFACS as the conceptual basis[4,5]. Following the method proposed by this theory for research related to human error[13], this study is classified as a questionnaire study, consisting of individual interviews aimed at understanding participants’ perceptions regarding errors and contributing factors.

The study setting was the adult Intensive Care Unit (ICU) of a public general hospital under federal administration, located in Rio de Janeiro, RJ, Brazil. The ICU has 12 active beds and serves patients with high complexity, including clinical and surgical cases across all specialties, with emphasis on orthopedics, neurology, and cardiology. It is considered a referral center by the Ministry of Health for medium- and high-complexity cases.

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Participants included statutory and contracted nursing professionals working in the ICU. Inclusion criteria were: being employed by the institution either as statutory or contracted staff, assigned to the ICU, and having worked in the sector for more than three months, considering the probation period defined by Article 445, Sole Paragraph of the Consolidation of Labor Laws (CLT) in Brazil. Professionals on leave during data collection due to vacations or other licenses were excluded.

Data were collected between December 5, 2022, and April 4, 2023, through individual interviews supported by a semi-structured interview guide. The guide consisted of questions about human factors contributing to errors in the nursing work process in the ICU. It was developed by the author based on a prior literature review and HFACS framework.

Interviews were conducted by the principal investigator in person and in a private location within the institution, at convenient times according to participants' availability. All interviews were audio recorded using an electronic device after informed consent was signed. Transcriptions were performed by the principal investigator with the aid of the Transkriptor platform and carefully reviewed afterwards.

Participant anonymity was guaranteed. Each received a code starting with the letter "E" for interview, followed by the sequence number of the interview conducted by the principal investigator. The first participant was assigned the code "E1", and subsequent participants were coded accordingly. Participant profiles were characterized by gender, age, professional training, role, and length of service in the ICU.

A Following transcription, the principal investigator created an analysis corpus, in which each interview was separated by a command line based on participant characterization variables.

The corpus underwent lexicometric analysis[14] using the free IRAMUTEQ® software (Interface de R for Multidimensional Text and Questionnaire Analysis). This program offers five lexical analysis tools: classic textual statistics, group specificity research, descending hierarchical classification, similarity analyses, and word cloud generation[15]. This study used descending hierarchical classification, which enables consistent data processing related to variables, text segments, subcorpora, and lexical classes.

All ethical aspects outlined in Resolution No. 466/2012 of the National Health Council for human research, and Resolution No. 510/2016 for research within the Brazilian Unified Health System (*Sistema Único de Saúde*, SUS), were observed. The research protocol received approval from the Research Ethics Committee of the proposing institution and from the Study Center of the participating institution. All participants signed the Informed Consent Form.

RESULTS

A total of twenty-five nursing professionals participated in the study, including nine nurses and 16 nursing technicians. Twenty-five interviews were conducted, each lasting a mean of 17 minutes, totaling seven hours of recordings. Recurrence and repetition of information were observed starting from the eighteenth interview, with one-third of interviews (n = 7) added in accordance with the data saturation safety margin[16].

Among participants, 80% were female (n = 20). Ages ranged from 29 to 72 years. Statutory employees accounted for 68% (n = 17), 52% held more than one employment relationship (n = 13), and length of service in the ICU ranged from 11 to 20 years.

Interview responses formed the corpus analyzed with IRAMUTEQ® software, achieving 85% corpus utilization. The Descending Hierarchical Classification dendrogram displayed the main analyzable words contained in the text segments (Figure 1).

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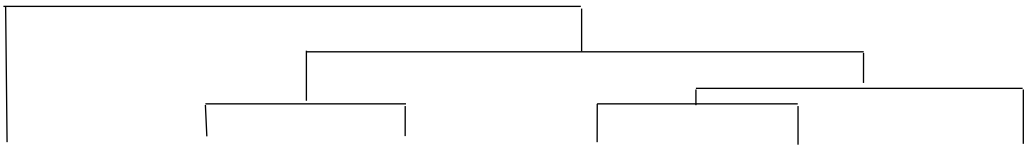

Classe 5 23%	Classe 4 14,6%	Classe 3 11,9%	Classe 1 20,4%	Classe 5 13,3%	Classe 2 16,5%
Medication	Job	Sick	Stay	Team	Relation
Error	Tired	Physical	Paper	Difficulty	Problem
Administer	Life	Afterwards	People	Communication	Safety
Incorrect	Workload	Visualization	More	Federal	Direction
Tap	Fatigue	Covid	Nurse	Leadership	Human resources
Switching	Schedule	Seek	Large	Nurse	Demand
Patient	24	Pandemic	Finish	Shift	Education
Positioning	Impair	Area	Therefore	Technician	Continue
Administration	Sleep	Floor plan	Bureaucracy	Well	Reallocation
Spoon	Colleague	Need	Lose	Hire	Committee
Place	Morning	Dipyrone	Old	Service	Always
Catheter	Night	Really	A lot	Better	Necessity
Prescribed	Isolation	Psychological	Contract	Calm	Unit
Blood	Fatigue	Help	Pressure	Total	Usual
Forget	Finish	Corrector	Here	Compare	Ward
Bed	Get tired	Work	Try	Way	Absence

Figure 1: Descending Hierarchical Classification Dendrogram. Rio de Janeiro, RJ, Brazil, 2023.

Subcorpus A resulted from the first corpus division, consisting of Class 6, comprising 23% of the corpus. The second division generated Subcorpus B, composed of Class 4 (14.8%) and Class 3 (11.3%), and Subcorpus C, composed of Classes 1 (20.4%), 5 (13.3%), and 2 (18.6%).

The subcorpora and lexical classes were named based on the interpretation of analyzable words and text segments, supported by the theoretical framework and scientific literature (Figure 2).

Subcorpora and Lexical Classes	Names for Subcorpora and Lexical Classes
Subcorpus A	**Unsafe acts in the nursing work process in intensive care**
Class 6	
Subcorpus B	**Preconditions for unsafe acts in the nursing work process in intensive care**
Class 4	Personnel factors in the ICU.
Class 3	Environmental factors and conditions of nursing professionals in the ICU.
Subcorpus C	**Unsafe supervision and organizational influences in the nursing work process in intensive care**
Class 1	Unsafe supervision and nursing leadership practice in the ICU.
Class 5	Types of employment bonds and organizational climate.
Class 2	Resource management, operational processes, and organizational climate in the ICU.

Figure 2: Names of Subcorpora and Lexical Classes. Rio de Janeiro, RJ, Brazil, 2023.

Text segments presented in the results were copied in full, as separated by the software, without researcher interference. Each segment was followed by the participant code assigned.

Thus, the following subcorpora were obtained: “Unsafe acts in the nursing work process in intensive care,” “Preconditions for unsafe acts in the nursing work process in intensive care,” and “Unsafe supervision and organizational influences in the nursing work process in intensive care,” presented below.

Unsafe acts in the nursing work process in intensive care

Unsafe acts were mainly reported by nursing technicians, who recognized error situations in the ICU work process, especially medication errors.

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> *An error is preparing incorrect medication. It includes everything, the wrong route, the wrong dose. The part about wrong medication is the worst to me. There are many errors, but this one is a major aggravating factor. (E13)*

> *I think an error is anything that negatively affects patient care, from simple care to incorrect medication administration. (E15)*

However, some interviewees, mainly nurses, did not recognize errors in nursing care in the ICU.

> *In the time I have been here, I have not noticed any errors. People are committed to care. When giving bed baths, it is done properly. Hygiene is done correctly. I have not seen any of those errors. (E10)*

In relation to the error types, skill-based errors such as lapses in attention were mentioned, potentially causing medication and identification errors, among others.

> *For example, you might administer the wrong medication due to inattention, by failing to check and confirm the bed, patient name, which can cause other problems as well. I think it's mostly about attention. (E5)*

Violations were related to deviations from institutional routines and protocols, mainly due to lack of material resources.

> *There are workarounds you have to do, like cutting the tip off a syringe to administer medication through an enteral tube. This harms the service; lack of supplies is really bad. (E2)*

Preconditions for unsafe acts in the nursing work process in intensive care

Preconditions included personnel factors, environmental factors, and conditions of nursing professionals in the ICU.

In relation to personnel factors, readiness difficulties were reported, highlighting fatigue and tiredness associated with external factors such as long weekly working hours due to multiple employments, especially among nursing technicians.

> *I see fatigue because people accumulate work hours in multiple jobs. It definitely interferes; people arrive tired from another job and perform less well somewhere. (E7)*

> *Our shift is 24 hours long, and most have another job elsewhere. Many work from home and have families, so especially during the night, colleagues try their best but natural strength is not enough. (E19)*

The institution's 24-hour shifts, combined with multiple employments, were cited as contributing factors to errors, particularly during the night.

> *I often say 24-hour shifts should not exist, because in an ICU, care is not the same at eight in the morning and three in the morning. (E20)*

Working in a closed high-complexity unit like the ICU on 24-hour shifts was considered a factor contributing to mental health issues.

> *The main concern about our health is mental, not physical. Here in the ICU, mental health is the biggest issue. If we do not take care of ourselves mentally or seek alternatives outside, we go crazy inside here, really. Being enclosed for 24 hours is tough. (E16)*

Regarding worker conditions, the impact of the COVID-19 pandemic on professionals' mental health was highlighted and remains evident.

> *I got sick mentally during the pandemic peak in 2020. I told them I would not come to work and stayed home for five days. I still receive follow-up care, as do many colleagues. (E7)*

Unsafe supervision and organizational influences in the nursing work process in intensive care

At the organizational level, unsafe supervision was identified, particularly due to inadequate nursing care management by nurses, linked to staff shortages.

> *Care planning used to be better. We had four nurses, and they could stay closer to patient care alongside technicians. Now, care management is mostly in the hands of technicians rather than nurses. (E22)*

High turnover of contracted professionals, especially nurses, contributed to lack of continuity in care and difficulty maintaining institutional routines.

> *Care planning nowadays leaves something to be desired. The nurse in charge changed routines again and is more attentive now, with new schedule implementations, like sedation. (E3)*

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Different employment contracts interfered with nurses' leadership roles. Contracted nurses felt intimidated by statutory nursing technicians.

> *There is a problem with nurse leadership here. Nurses feel intimidated because most are younger than the nursing technicians. (E2)*
>
> *Nurses tend to be passive and do not expose themselves because 99% are contracted, and many technicians have federal statutory status. Some can assert themselves, but most ignore issues. Unfortunately, it is sad. (E13)*

DISCUSSION

Human factors are not necessarily linked to error but rather to the interaction between individuals and the systems in which they operate. This interaction may be positive or negative depending on organizational, environmental, and operational conditions. Human factors can both enhance patient safety and predispose organizations to active failures and latent conditions. This study's results showed that organizational factors directly contribute to errors in the nursing work process in intensive care.

To better understand human factors contributing to error in nursing work in intensive care, the four hierarchical levels proposed by HFACS[4,5] were considered: unsafe acts (errors and violations); preconditions for unsafe acts (environmental factors, operator conditions, personnel factors); unsafe supervision (inadequate supervision, inappropriate operation planning, failure to correct known problems, supervisory violations); and organizational influences (resource management, organizational climate, operational process).

Among unsafe acts reported, medication errors stood out. Nursing technicians acknowledged medication errors in the ICU, unlike nurses, which may relate to their responsibility for medication administration. This aligns with an integrative review highlighting environmental influences on medication errors, such as interruptions, workload, and inadequate medication preparation areas[17].

Lack of error recognition by professionals and institutions may indicate a reductionist view that equates error solely with adverse events. This lack of recognition is an element of Vulnerable System Syndrome[18], characterized by blaming individuals, denying systemic errors, and inappropriate focus on productivity and financial indicators.

Vulnerable System Syndrome is directly related to the persistence of punitive culture in institutions, hindering safety culture development[18]. In this study, different employment contracts affected nursing professionals' interaction with the work environment. Nursing technicians mostly had federal statutory contracts, whereas many ICU nurses were contracted employees without job stability. Fear of punishment, such as dismissal, contributes to error denial and influences professional behavior during task performance.

Routine violations, identified in participant reports, represent intentional deviations tolerated by management, linked to personal or systemic factors. In the ICU, routine violations commonly relate to lack of adequate resources, equipment malfunction, lack of training, and poor working conditions[19], which participants corroborated.

Preconditions for unsafe acts revealed that many nursing professionals have multiple employment relationships, increasing weekly working hours. Among participants, 52% reported two or more jobs, contributing to readiness difficulties associated with fatigue and lapses in attention[20].

Long work shifts can reduce care safety due to worker fatigue. One study evaluating nurse performance after long shifts found significant performance impairment after three consecutive 12-hour shifts, with slower response, more lapses, and reduced cognition, especially among night shift workers[21].

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The ICU in this study operates on 24-hour shifts, meaning nursing professionals working a 12-hour job elsewhere automatically perform three consecutive 12-hour shifts, totaling 36 continuous work hours. Night shifts can impair mental and physiological status, increasing errors and violations. Sleep deprivation also affects mood and interpersonal relationships, acting as a major stressor and contributing to cardiovascular diseases and premature mortality[22].

The COVID-19 pandemic deserves special mention. Participants reported it as a factor affecting health and work quality. Nursing Observatory data recorded 52,277 cases and 744 deaths among nursing professionals in Brazil[23]. Working on the front line during the pandemic increased professionals' vulnerability, significantly affecting mental health and increasing psychiatric disorders and burnout syndrome[24,25].

Stress from facing COVID-19 also intensified negative physical, mental, and behavioral effects among workers, such as insomnia, insecurity, sadness, feelings of incapacity, increased use of alcohol, tobacco, and other drugs, lack of energy, and general pain[26-28]. Organizationally, the pandemic increased workloads and shortages of human and material resources[29-31]

Regarding unsafe supervision and organizational influences, nurse leadership was highlighted, directly affected by different employment contracts and staff turnover, especially among nurses.

Leadership plays a crucial role in patient safety and is a key strategy in developing high-reliability organizations. There is a need to enhance clinical and managerial leadership skills focusing on eliminating avoidable harm in healthcare[2].

Among leadership styles, transformational leadership is recommended for patient safety contexts. It is based on shared values between leaders and followers, as well as organizational values. Transformational leaders empower and influence others, focusing on organizational goals from a broad perspective[33,34].

However, in this ICU, punitive culture, professionals' insecurity, precarious employment, and lack of job stability negatively affect nurses' leadership roles. This influences nursing team performance and care management. Inadequate or absent leadership and supervision contribute to conflicts, communication difficulties, poor decision-making, teamwork problems, and increased errors and violations[35].

Proper leadership and supervision by nurses can foster collaboration among team members and improve service quality. Management is a core and exclusive nursing function involving numerous responsibilities, and its effectiveness is directly related to organizational influences[36].

Therefore, recognizing human factors is fundamental to strengthening patient safety culture, especially in high-complexity settings such as ICUs. To achieve high reliability, health systems and services must seek effective strategies to mitigate existing risks and create safe environments for patients and professionals[2,4,13].

This study contributes scientific knowledge on human factors contributing to errors in the nursing work process in intensive care. Understanding these factors supports adopting strategies to improve health services, working conditions, and the quality and safety of nursing and healthcare.

Study limitations

The study's limitation lies in data collection from a single unit, limiting generalization of results to other contexts. To achieve broader and more detailed analysis of human factors, replication in other health contexts and services is recommended.

CONCLUSION

The analysis of human factors contributing to error in the intensive care work process allowed understanding nursing professionals' perceptions regarding error and human factors related to individuals, the environment, leadership, and the institution. The results highlighted that organizational factors directly impact error occurrence in the nursing work process, making investment in organizational safety culture essential to achieve high reliability.

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In this regard, Human Error Theory and HFACS enabled comprehension of how human factors interrelate and contribute to errors and violations across different hierarchical levels. Among strategies to mitigate error situations, investing in safe environments for nursing and healthcare professionals stands out, along with valuing employment stability and providing adequate working conditions, which will lead to improvements in quality and safety in healthcare and nursing care.

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Use of artificial intelligence tools

Authors declare that no artificial intelligence tools were used in the composition of the manuscript "*Contributing human factors to nursing errors in intensive care therapy*".