

Comprehensive Occupational Hazard Identification and Risk Control in Hospital Inpatient Units: A HIRACS Perspective

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ABSTRACT

Introduction: Occupational Health and Safety (OHS) in hospital inpatient units is a critical concern due to the high exposure of healthcare workers to various hazards, including biological, chemical, physical, and ergonomic risks. The dynamic nature of inpatient care activities increases the likelihood of occupational incidents, which may affect both worker safety and patient outcomes. Therefore, a systematic risk assessment approach is required to identify and control potential hazards effectively.

Objectives: This study aims to provide information for targeted control measures to improve worker safety in hospital inpatient settings.

Methods: This study employed a descriptive observational design using the Hazard Identification, Risk Assessment, and Control (HIRACS) method. Data were collected through direct observation, interviews, and documentation review in the inpatient unit of a hospital. The risk assessment process involved identifying work activities, classifying hazards, determining likelihood (L) and severity (S), and calculating risk levels ($R = L \times S$). Informants included key healthcare personnel responsible for inpatient services.

Results: The findings identified multiple occupational hazards across inpatient activities, including medication errors ($R=12$), needle stick injuries ($R=12$), exposure to disinfectants ($R=9$), ergonomic risks from patient handling ($R=9$), and electrical hazards ($R=8$). Biological hazards were the most dominant, particularly related to exposure to infectious materials and sharp objects. Several risks were categorized as moderate to high, requiring immediate control measures. Existing controls included the use of personal protective equipment (PPE), standard operating procedures, and equipment maintenance. However, gaps were still identified, such as inconsistent PPE compliance, inadequate training, and limited hazard communication.

Conclusion: The application of the HIRACS method proved effective in systematically identifying and evaluating occupational risks in inpatient units. Strengthening control measures, including staff training, strict adherence to safety protocols, and improved hazard communication, is essential to minimize workplace risks. Continuous monitoring and evaluation are recommended to enhance OHS performance and ensure a safer healthcare environment.

Keywords: Occupational Health and Safety; HIRACS; Risk Assessment; Inpatient Unit; Healthcare Workers; Hospital Safety

INTRODUCTION

Occupational health and safety (OHS) has received increasing attention in recent years as a critical component of healthcare quality and workforce well-being worldwide (Leong, K. B. R., Q. X. Ng, W. H. Gan, 2024). Healthcare environments are complex systems where clinical and non-clinical personnel face a wide range of workplace hazards, ranging from biological exposures to ergonomic demands and psychosocial stressors (Lestari, H., 2024). Although much of the existing literature has focused on clinical staff injury rates and infection control, non-clinical functions such as hospital food service operations are areas of concern due to the potential for significant occupational risks (Alqurashi, R. M., A. Farid, M. A. Alghamdi, 2025). Integrating occupational risk management into hospital administration systems has been shown to reduce the incidence of work-related injuries and improve the overall safety culture (Lestari, H., 2024). International guidelines on OSH emphasize proactive methods for hazard recognition and risk mitigation, arguing that a structured approach allows organizations to prioritize interventions based on the severity of impact and likelihood of occurrence (ILO, 2023a). Among recognized frameworks for systematic hazard analysis, the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) method has been widely adopted across various workplace activities due to its clear procedural steps and adaptability to various operational contexts (Fais, M., I. Deviyanti, 2024).

HIRARC operates through a sequential process of identifying workplace hazards, assessing the associated risk level by combining likelihood and severity metrics, and determining appropriate control measures to mitigate the identified risks (NIOSH, 2023). The method's emphasis on risk quantification allows organizations to not only classify hazard severity but also strategically deploy resources to address hazards with the greatest potential impact (Davis, J., 2023). Recent research has shown that the implementation of HIRARC contributes to measurable increases in risk awareness and reductions in occupational incident rates, particularly in the manufacturing and healthcare support services sectors (Rahman, S., 2024).

Despite the documented effectiveness of HIRARC in industrial and clinical settings, there remains a significant gap in the literature regarding its application specifically to hospital inpatient settings (Wright, J., 2024). Recognizing this gap, this study seeks to apply the HIRARC methodology to assess occupational hazards within a hospital inpatient setting. By systematically mapping risk levels and identifying the dominant hazard types across work processes, this study aims to provide information for targeted control measures to improve worker safety in hospital inpatient settings. These findings are expected to contribute to practical improvements in hospital OHS programs and scientific discourse on risk management in healthcare support services, ultimately supporting a safer work environment for hospital inpatient personnel.

MATERIALS AND METHODS

Study Design and Setting

This study employed a descriptive observational design to systematically identify and assess occupational health and safety (OHS) risks, exploring real working conditions and identifying workplace hazards without manipulating variables (Setiawan, 2022). The research was conducted in the inpatient unit of 'Aisyiyah Kudus Hospital, Indonesia, which involves various clinical and non-clinical activities such as medication administration, patient handling, medical equipment usage, and environmental cleaning. These activities were selected due to their high potential for exposure to biological, chemical, physical, and ergonomic hazards commonly reported in hospital environments (Putri, Andini R., 2023).

Data Collection Methods

Data were collected through direct observation, semi-structured interviews, and document review. Observations were carried out to identify routine work processes and potential hazards in each activity. Interviews were conducted with key informants, including nursing staff and unit supervisors, to obtain in-depth information regarding work practices and existing safety measures. In addition, relevant documents such as standard operating procedures (SOPs) and safety guidelines were reviewed to support data validation. The combination of these methods enhances the reliability and validity of occupational risk assessments in healthcare research (Wulandari, 2021).

Data Analysis and Risk Assessment Framework

The study utilized the Hazard Identification, Risk Assessment, and Control (HIRACS) method as the primary analytical framework. HIRACS is a systematic approach used to identify hazards, assess risks based on likelihood and severity, and determine appropriate control measures to minimize workplace risks (Ramli, 2020). The hazard identification process involved classifying hazards into categories such as biological, chemical, physical, and ergonomic hazards.

Risk assessment was conducted by assigning values to likelihood (L) and severity (S) for each identified hazard, followed by calculating the risk level ($R = L \times S$). The results were then categorized into risk levels (low, moderate, high) to prioritize control actions. This semi-quantitative approach is widely applied in occupational safety studies due to its practicality and effectiveness in prioritizing workplace risks (Sari, 2023). Control measures were analyzed based on the hierarchy of controls, including elimination, substitution, engineering controls, administrative controls, and the use of personal protective equipment (PPE). This hierarchy is recommended as a standard framework for minimizing occupational risks in healthcare settings (ILO, 2023b). The findings were then presented in a HIRACS table to provide a comprehensive overview of hazards, risk levels, and recommended control strategies.

RESULTS

The results of this study present the identification of occupational hazards, risk assessment, and control measures in the inpatient unit using the HIRACS method. A total of 12 work activities were analyzed, covering clinical and non-clinical tasks performed by healthcare workers. The findings indicate that workers in inpatient units are exposed to various hazards, including biological, chemical, physical, and ergonomic risks.

Overall, the analysis shows that biological hazards are the most dominant, particularly those related to exposure to blood, body fluids, and infectious patients. In addition, several high-risk activities ($R \geq 12$) were identified, including medication administration errors and needle stick injuries. Moderate risks ($R = 8-9$) were also commonly observed in activities involving chemical exposure, patient handling, and equipment use.

Table 1. HIRACS Analysis in Inpatient Unit

No	Work Activity	Potential Hazard	Hazard Type	Impact/Risk	L	S	R	Risk Level	Existing Control	Recommendation
1	Medication administration	Wrong dose/type	Chemical / Human error	Drug reaction, poisoning	3	4	12	High	Double-check (6 rights)	Drug system labeling
2	IV line/catheter insertion	Exposure to blood	Biological	HIV, Hepatitis B	2	4	8	Moderate	Use of gloves	Hand hygiene campaign
3	Cleaning patient rooms	Disinfectant exposure	Chemical	Skin irritation, respiratory issues	3	3	9	Moderate	PPE use	Eco-friendly disinfectant
4	Patient mobilization	Slips/falls	Physical	Injury, fractures	2	3	6	Low	Assistance by staff	High-risk patient labeling
5	Medical electrical equipment	Short circuit	Physical	Burns, fire	2	4	8	Moderate	Routine maintenance	Cable management
6	Medical waste handling	Needle stick injury	Biological	Infection transmission	3	4	12	High	Safety box use	Injection safety training
7	Vital signs measurement	Contact with infectious patients	Biological	Disease transmission	2	3	6	Low	PPE use	Patient isolation
8	Cleaning medical equipment	Exposure to body fluids	Biological	Infection	3	3	9	Moderate	Sterilization	Equipment cleaning training
9	Patient lifting	Poor ergonomics	Ergonomic	Musculoskeletal disorders	3	3	9	Moderate	Patient transfer tools	Ergonomic training
10	Chemical storage	Hazardous spills	Chemical	Burns, irritation	2	4	8	Moderate	B3 storage cabinet	Spill provision kit
11	Oxygen use	Gas leakage	Physical	Explosion risk	2	4	8	Moderate	Liquid O2 system	Monitoring system
12	Inappropriate PPE use	No PPE	Biological/Physical	Infection risk	3	3	9	Moderate	PPE availability	Safety signage

Findings Interpretation

The results indicate that two activities fall into the high-risk category, namely medication administration errors and needle stick injuries, both with a risk score of 12. These risks are critical as they may result in severe consequences, including life-threatening conditions for both patients and healthcare workers.

Most activities (8 out of 12) fall into the moderate risk category, suggesting that although control measures are already in place, they are not yet fully effective. Common contributing factors include inconsistent use of personal protective equipment (PPE), lack of training, and insufficient hazard awareness.

Meanwhile, low-risk activities were identified in patient mobilization and vital sign measurement; however, these still require attention to prevent escalation of risk. Based on the HIRACS evaluation of the 12 observed activities in the inpatient unit, the distribution of hazards and risk levels is summarized in Table 1 below.

Table 1. Summary of Hazard Classification and Risk Level Distribution (*n* = 12 activities)

Category / Indicator	Classification / Level	Frequency (n)	Percentage (%)
Hazard Classification	Biological Hazards	5	41.7
	Chemical Hazards	3	25.0
	Physical Hazards	3	25.0
	Ergonomic Hazards	1	8.3
Risk Level Distribution	High Risk	2	16.7
	Moderate Risk	8	66.7
	Low Risk	2	16.7
Total Analyzed Activities	—	12	100

In terms of hazard classification, biological hazards dominate (5 out of 12 activities, or 41.7%), followed by chemical (3), physical (3), and ergonomic hazards (1). This highlights the high exposure of healthcare workers to infectious materials and emphasizes the need for stricter infection control practices.

DISCUSSION

Hazard Identification

The findings of this study indicate that biological hazards are the most dominant risks in inpatient units, particularly those related to exposure to blood, body fluids, and infectious patients. This result is consistent with previous studies showing that healthcare workers are at high risk of infection due to frequent contact with patients and contaminated materials (Situmorang, 2024). In terms of hazard classification, the presence of chemical hazards from disinfectants and hazardous substances also requires attention. Exposure to cleaning agents may cause respiratory problems and skin irritation if not properly managed (Putri, 2023). Furthermore, physical hazards, such as electrical risks and patient falls, highlight the need for routine equipment maintenance and improved environmental safety management (Sari, 2023). In addition, the study identified ergonomic risks associated with manual patient handling, which may lead to musculoskeletal disorders among healthcare workers. This finding is supported by research indicating that repetitive lifting and improper body posture are major contributors to work-related musculoskeletal injuries in hospitals (Yusmaini, Y., 2024).

Risk Assessment

Most identified hazards fell into the moderate risk category, indicating that existing control measures are present but not fully effective. This condition may be attributed to inconsistent compliance with safety procedures, insufficient supervision, and lack of continuous training (WHO, 2022). The study also identified high-risk activities, particularly medication administration errors and needle stick injuries, both categorized as high risk ($SR = 12\$$). Medication errors remain a significant concern in inpatient care due to complex drug administration processes and human factors such as fatigue and workload (Alghamdi, 2023). Similarly, needle stick injuries are widely reported as one of the most common occupational hazards among healthcare workers, with serious implications such as the transmission of blood-borne diseases like Hepatitis B, Hepatitis C, and HIV (Mersal, 2025). The application of the HIRACS method in this study proved effective in systematically identifying hazards, assessing risk levels, and determining appropriate control measures. Similar findings have been reported in other studies, where HIRACS provides a structured framework for prioritizing risks and improving workplace safety (Zahra, Auliya, 2024).

Risk Control

The high prevalence of biological hazards highlights the importance of strengthening infection prevention and control (IPC) measures, including the proper use of personal protective equipment (PPE) and adherence to standard precautions (WHO, 2022). These findings emphasize the need for the strict implementation of safety protocols, including double-check systems and safe injection practices. Previous research suggests that ongoing education and training programs significantly improve workers' awareness and compliance with OHS practices (Pramusiwi, Widi Mahasih, 2024). Therefore, strengthening training programs and monitoring systems is crucial to reducing risk levels. To address chemical and ergonomic hazards, the use of environmentally friendly disinfectants, proper chemical handling procedures, assistive devices, and ergonomic training are essential to minimize occupational risks. Despite these findings, this study has several limitations. The data were collected from a limited number of respondents and focused on a single inpatient unit, which may affect the generalizability of the results. However, the study still provides valuable insights into occupational risk patterns and control strategies in hospital settings. Future studies are recommended to involve larger samples and multiple hospital units to obtain more comprehensive results (Zahra, Auliya, 2024).

CONCLUSIONS

This study demonstrates that the application of the HIRACS method is effective in systematically identifying, assessing, and prioritizing occupational health and safety (OHS) risks in hospital inpatient units. The findings reveal that biological hazards are the most dominant risks, particularly those related to exposure to blood, body fluids, and infectious patients. In addition, high-risk activities such as medication administration errors and needle stick injuries require immediate attention due to their potential to cause severe harm to both healthcare workers and patients. Most identified risks fall into the moderate category, indicating that existing control measures are in place but not yet optimal. Factors such as inconsistent use of personal protective equipment (PPE), limited training, and inadequate supervision contribute to the persistence of these risks. Therefore, strengthening OHS implementation through continuous training, strict adherence to safety protocols, and improved hazard communication is essential. Furthermore, integrating the hierarchy of controls with the HIRACS framework can enhance risk management effectiveness in healthcare settings. Continuous monitoring and evaluation are recommended to ensure the sustainability of control measures and to improve overall workplace safety performance. Future research should involve a larger sample size and multiple hospital units to provide more comprehensive and generalizable findings.

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Availability of data and materials

All data generated or analysed during this study are included in this published article.

Authors' contributions

AF conceptualized and designed the study, developed the research framework and hypotheses, conducted data collection and statistical analysis, interpreted the findings, and drafted as well as critically revised the manuscript. The author approved the final version of the manuscript and agrees to be accountable for all aspects of the work, ensuring its accuracy and integrity.

Conflict of Interest

There is no conflict of interest in this research.

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