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# From Incident to Improvement: A Root Cause Analysis of Needle Stick Injuries in a Private Type-C Hospital in Indonesia

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**ABSTRACT**

**Introduction:** Needle stick injuries (NSIs) remain one of the most persistent occupational hazards among healthcare workers (HCWs), posing significant risks of exposure to blood-borne pathogens. Despite continuous implementation of infection prevention and control (IPC) programs, NSIs continue to occur across healthcare settings, reflecting both behavioral and systemic vulnerabilities.
**Objective:** This study aimed to analyze the characteristics and underlying causes of NSIs using a Root Cause Analysis (RCA) approach in a private type-C hospital in Bogor, Indonesia.
**Methods:** A descriptive retrospective study was conducted using secondary data from the hospital's incident reporting system between January 2022 and October 2025. Descriptive statistics were used to summarize NSI trends by year, professional category, and department. One representative NSI case was further examined using the Ishikawa 6M (Man, Method, Machine, Material, Measurement, and Milieu) framework to identify root causes and develop targeted corrective and preventive actions.
**Results:** Seventeen NSIs were reported during the study period. Nurses were the most affected group (58.8%), and inpatient wards were the most common locations (35.3%). RCA revealed contributing factors including excessive workload, limited awareness of safety protocols, inadequate preparation and equipment availability, use of non-safety needles, lack of compliance monitoring, and overcrowded work environments. The resulting action plan encompassed staff training, workload adjustments, equipment upgrades, workspace reorganization, and regular compliance audits.
**Conclusions:** NSIs in this setting were driven by both human and system-level factors. Addressing behavioral, procedural, and environmental weaknesses through integrated corrective and preventive measures is essential to strengthening IPC practices and fostering a culture of safety among HCWs.

## Introduction

Healthcare workers (HCWs) experience more than two million occupational needle stick injuries (NSIs) each year, making NSIs one of the most common occupational hazards in healthcare settings and a major source of exposure to blood-borne pathogens such as hepatitis B, hepatitis C, and human immunodeficiency virus (HIV) (Bouya et al., 2020; Alfulayw et al., 2021; McPake et al., 2022). Despite ongoing infection prevention and control (IPC) efforts, NSIs continue to occur in many healthcare settings, especially in low- and

middle-income countries where reporting is often incomplete and adherence to safety procedures remains inconsistent (Abalkhail et al., 2022; Behzadmehr et al., 2023). Effective IPC programs play a central role in reducing the risk of occupational exposure through surveillance, staff training, and continuous monitoring of compliance with standard precautions (Alhumaid et al., 2021; Lee et al., 2024). Nevertheless, NSIs continue to occur even in hospitals with well-established incident reporting systems (Sahebi et al., 2025), suggesting that underlying system factors and latent conditions may contribute to their persistence.

In hospitals, HCWs across multiple departments including nurses, physicians, laboratory personnel, and housekeeping staff are all at potential risk of exposure to contaminated sharps (Abalkhail et al., 2022; Rai et al., 2021). The presence of an incident reporting system enables timely documentation and follow-up, yet understanding why these events continue to occur requires a more systematic investigation of underlying causes (Amaniyan et al., 2020). Root Cause Analysis (RCA) provides a structured method for identifying contributing factors beyond individual error, focusing on system weaknesses such as workflow design, workload, communication, and compliance gaps (Singh et al., 2024). Persistent gaps in patient safety implementation, including incomplete adherence to safety goals, inadequate communication, and inconsistent compliance with standard procedures, have also been documented in Indonesian healthcare facilities, underscoring the importance of system-level evaluation and continuous monitoring (Hermawan et al., 2022; Iryawati et al., 2023). However, evidence on the application of RCA to NSIs in low- and middle-income country settings, including Indonesia, remains limited.

This study applied the RCA framework to analyze NSIs in a private type-C hospital in Bogor, West Java. As type-C hospitals comprise most private facilities and employ many frontline HCWs, the findings provide actionable insights to inform targeted IPC interventions and enhance workplace safety in similar settings.

## Methods

### *Study Design and Setting*

This descriptive retrospective study was conducted in a private type-C hospital located in Bogor City, West Java, Indonesia. All reported NSIs among healthcare workers were analyzed using data from the hospital's IPC surveillance and incident reporting system. The study covered incidents occurring between January 2022 and October 2025.

For the purpose of this study, a NSI was defined as any percutaneous injury caused by a needle or sharp medical device that had the potential to result in exposure to blood or other potentially infectious materials, in accordance with the hospital's IPC reporting criteria. All reported cases were verified by the IPC team through review of incident documentation and follow-up records prior to inclusion in the analysis.

Each incident report contained detailed information on event characteristics and follow-up procedures. The recorded variables included the date and time of injury, staff name and profession (such as nurse, resident medical officer, specialist, laboratory analyst, or cleaner), work unit (inpatient ward, outpatient department, operating theatre, and others), and employment duration. The report also documented the specific activity during which the incident occurred (for example, intravenous insertion, blood collection, waste disposal, needle recapping, or suturing), the type of needle involved (wing needle, vasofix, insulin needle, etc.), and the exact location of the injury on the body.

Additional fields captured the injury category (NSI or sharp injury), cause classification (unsafe act or unsafe condition), and details of the exposure source examination. Information on post-exposure management included the date of testing and the results for hepatitis B surface antigen (HBsAg), hepatitis C, and HIV for both the source patient and the exposed staff. The form also documented patient consent, financial responsibility for the tests (covered by the hospital, BPJS Kesehatan, which is Indonesia's National Health Insurance Program, or the HCW), and a chronological description of the incident.

Furthermore, the report collected data on staff awareness and preparedness, including whether the staff member understood relevant standard operating procedures (SOP), had received prior sharps safety education, and had been vaccinated against hepatitis B. Additional laboratory results included anti-HBs antibody titers, HBsAg, hepatitis C, and HIV tests, along with follow-up testing at three and six months post-exposure. Finally, each report contained an internal RCA section summarizing the identified root cause, analytic notes, and proposed action plans.

One representative case from 2025 was selected for in-depth RCA using the Ishikawa 6M framework (Man, Method, Machine, Material, Measurement, and Milieu). This case was chosen because it occurred in the inpatient ward, which recorded the highest number of NSIs during the study period. The RCA was conducted collaboratively by the IPC and Patient Safety teams to identify contributing factors and systemic gaps requiring corrective and preventive interventions.

### *Data Analysis*

Descriptive statistical analysis was performed to summarize the characteristics of NSIs according to year, hospital department, and professional category. Data were tabulated to identify temporal trends and high-risk units. Thematic analysis was subsequently applied to the RCA findings to explore behavioral, environmental, and systemic contributing factors. Each identified factor was classified based on the 6M framework categories. Corrective and preventive actions were then organized into short-, medium-, and long-term plans according to feasibility and implementation priority.

### *Ethical Considerations*

This study formed part of a hospital-based quality improvement initiative within the IPC framework. In line with institutional policy, the use of routinely collected, anonymized secondary data exempted the study from formal ethical review. No direct interaction or access to individual-level identifiers occurred, and data confidentiality was maintained throughout.

## Results and Discussion

### *Temporal Trends of NSIs*

A total of 17 NSI incidents were reported between January 2022 and October 2025, with noticeable year-to-year fluctuations **(Figure 1)**. The annual distribution showed five incidents in 2022 and 2023, a decrease to one incident in 2024, and an increase to six incidents in 2025. These variations suggest inconsistent adherence to IPC practices and potential differences in reporting habits, staff workload, and safety oversight over time. Similar temporal patterns have been observed in other settings, where NSI rates tend to shift with changes in workforce density, institutional safety culture, and managerial emphasis on IPC (Öztürk, 2024). The overall incidence corresponds to 0.72 NSIs per 1,000 staff-days, providing a simple descriptive measure of NSI frequency over the study period. Continuous surveillance and reinforcement of safe sharps handling are therefore essential to maintain stable reductions in NSI incidence.

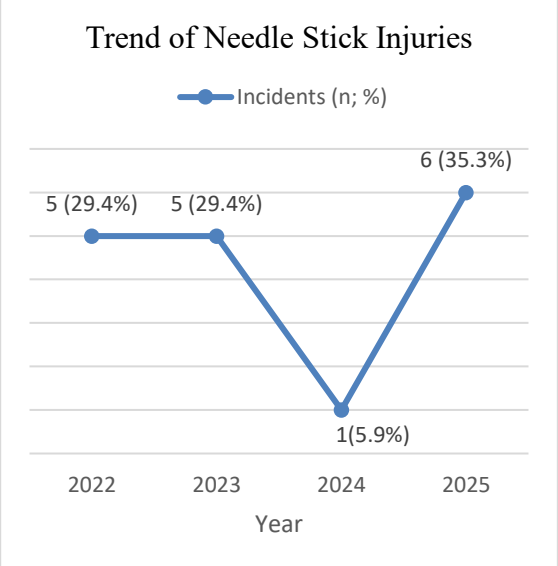


**Figure 1.** Trend of NSIs from January 2022 to October 2025.

**Source:** Hospital Incident Reporting System (2022–2025)

### *Staff and Location Distribution*

Nurses accounted for the largest proportion of incidents (10 of 17, 58.8%), followed by physicians and laboratory personnel (each 17.6%), and one non-clinical staff member (5.9%) **(Table 1)**. This indicates that more than half of NSIs occurred among nursing staff, reflecting their high frequency of direct patient contact and invasive procedures.

Most incidents occurred in inpatient wards (35.3%) and the emergency department (29.4%), with outpatient clinics and laboratories contributing three incidents each **(Figure 2)**. Together, inpatient wards and emergency departments accounted for nearly two-thirds (64.7%) of all reported NSIs, reflecting international evidence linking high workload, patient flow pressure, and limited maneuvering space with increased sharps-related injury risk (Öztürk, 2024).

**Table 1.** Distribution of NSIs by Year and Staff Role

| Year | Doctor | Nurse | Laboratory Personnel | Others | Total |
|---|---|---|---|---|---|
| 2022 | 1 | 3 | 1 | 0 | 5 |
| 2023 | 0 | 3 | 2 | 0 | 5 |
| 2024 | 0 | 1 | 0 | 0 | 1 |
| 2025 | 2 | 3 | 0 | 1 | 6 |
| Total (n) | 3 | 10 | 3 | 1 | 17 |
| Percent (%) | 17.6 | 58.8 | 17.6 | 5.9 | 100 |

Source: Hospital Incident Reporting System (2022–2025)

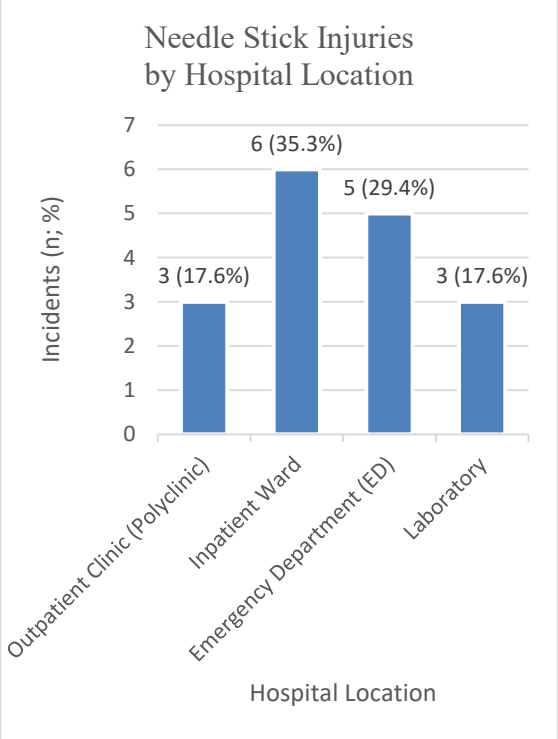


**Figure 2.** Distribution of NSIs by hospital location. The column chart illustrates the frequency of NSIs across departments, highlighting inpatient wards and emergency departments as high-risk units.

**Source:** Hospital Incident Reporting System (2022–2025)

### *RCA of an NSI Incident*

The RCA of a representative NSI case involving a nurse in the inpatient ward identified contributing factors across human, technical, environmental, and systemic domains. A total of nine contributing factors were identified through the RCA process. Key human contributors

included rushing due to workload, limited awareness of safety protocols, and inadequate preparation. Technical contributors were the use of non-safety-engineered needles and inconsistent equipment availability. Environmental contributors included crowded workspaces and peak-hour congestion, while systemic contributors included limited SOP monitoring and absence of feedback mechanisms.

Human-related factors accounted for the largest proportion of identified contributors (3 of 9), followed by environmental factors (2 of 9), technical factors (2 of 9), and system-related measurement gaps (2 of 9). No procedural errors were identified under the "Method" category, suggesting the incident stemmed from human and organizational vulnerabilities rather than incorrect clinical technique. These findings are summarized using the Ishikawa 6M framework **(Figure 3)**.

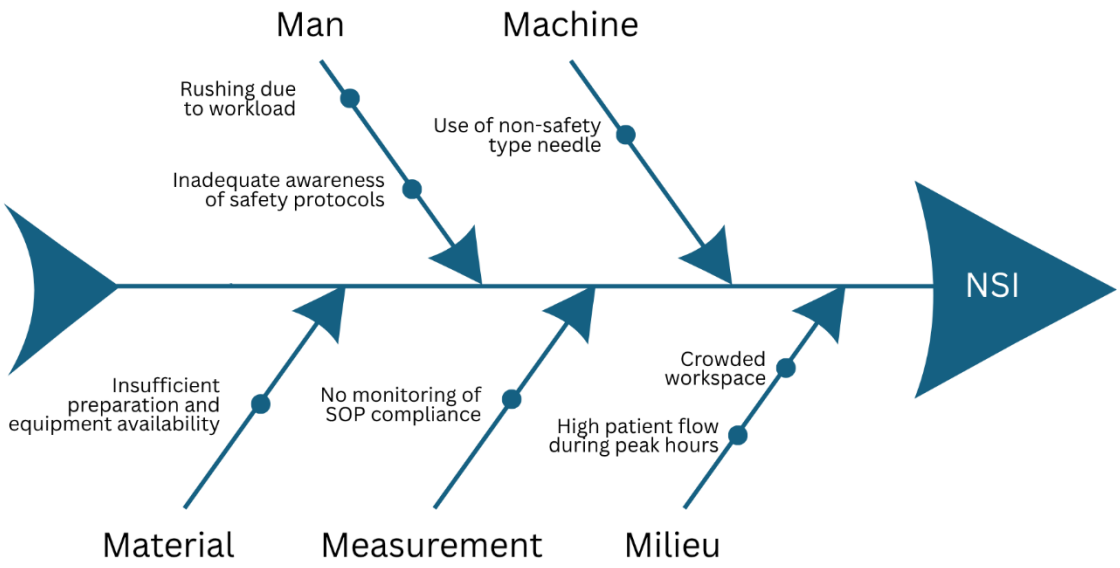


**Figure 3.** Fishbone diagram illustrates the root causes of the NSI event based on the 6M framework. The analysis revealed that human and environmental factors dominated the event. SOP = Standard Operating Procedure; NSI = Needle Stick Injury.

**Source:** Hospital Incident Reporting System (2022–2025)

### *Corrective and Preventive Measures*

Corrective and preventive actions addressed human factors, system gaps, technical issues, and environmental constraints. Each identified contributing factor was matched with at least one corrective or preventive action, resulting in a total of seven targeted interventions. Key

interventions included staffing adjustments, quarterly IPC refresher training, replacement of non-safety needles with safety-engineered devices, routine SOP compliance audits, workspace reorganization, and alignment of staffing with patient flow. These interventions are summarized in **Table 2**.

**Table 2.** Corrective and Preventive Action Plan Based on RCA Findings.

| Identified Cause | Proposed Action | Responsible Unit | Timeline |
|---|---|---|---|
| Rushing due to workload (Man) | Adjust shift allocation and ensure adequate staffing to reduce workload pressure | Nursing Management | 2 months |
| Inadequate awareness of safety protocols (Man) | Conduct refresher IPC and sharps safety training for all nurses | PPI Committee, Nursing Department | Quarterly |
| Use of non-safety type needle (Machine) | Replace with safety-engineered needles | Logistic & Procurement Unit | 1 month |
| Insufficient preparation and equipment availability (Material) | Ensure availability of all necessary equipment before procedures | Nursing Department, Logistic Unit | 1 month |
| No monitoring of SOP compliance (Measurement) | Implement regular audits and monitoring of SOP adherence | Hospital Quality & Safety Team | Ongoing |
| Crowded workspace (Milieu) | Reorganize workspace to reduce congestion and improve workflow | Nursing Management, Facility Unit | 2 months |
| High patient flow during peak hours (Milieu) | Schedule staffing to match patient flow and reduce peak-hour crowding | Nursing Management | 2 months |

### *Interpretation and Policy Implications*

The fluctuating NSI trends and the multifactorial root causes identified in this study highlight the need for sustained and coordinated safety interventions. Although formal trend analysis was not conducted, descriptive findings indicate concentration of NSIs among nurses and high-risk units, emphasizing priority areas for intervention. Adoption of safety-engineered devices supported by adequate training has been shown to significantly reduce NSI rates (Bouya et al. 2020), while a strong institutional safety culture helps mitigate risk even in high-pressure environments (Rai et al. 2021). Addressing environmental and organizational contributors is therefore as essential as strengthening individual competence.

These findings also highlight the potential underestimation of NSIs due to underreporting, emphasizing the need for continuous monitoring and standardized reporting practices. They further reinforce compliance with Indonesia's Regulation of the Minister of Health No. 27/2017 on IPC, which mandates continuous surveillance, competency development, resource adequacy, and performance monitoring. Implementing the RCA-based interventions described in this study can help hospitals meet national IPC requirements and

accreditation standards, while fostering a safer environment for healthcare workers and improving overall patient safety.

## Conclusion

This study confirms that NSIs in healthcare settings result from the interplay of human, procedural, environmental, and systemic factors rather than isolated errors. Although standard operating procedures were adequate, gaps in workload management, equipment readiness, and compliance monitoring contributed to the persistence of incidents. Strengthening infection prevention and control training, ensuring adequate staffing, adopting safety-engineered devices, and establishing structured monitoring and feedback systems are essential for sustainable prevention.

Developing a culture of safety that emphasizes shared responsibility among healthcare workers and hospital leadership is fundamental to long-term success. By integrating behavioral reinforcement, system optimization, and continuous evaluation, healthcare institutions can create safer environments for both staff and patients while fostering institutional resilience in IPC.

## Conflict of Interest

No conflict of interest in this study

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