Vol 5 No.3 (2026) - Agustus, pp 2497-2503 https://www.doi.org/10.59025/wp7ehg83

Jurnal Masyarakat Madani Indonesia
e-ISSN: 2829-6702
https://syadani.onlinelibrary.id/

Enhancing Competency of ICU and NICU Nurses in Patient Safety Implementation for Infection Prevention in Invasive Procedures at Ratu Mas Hospital, 2025

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INFO ARTIKEL

Diserahkan 05/06/2026
Direvisi 18/06/2026
Diterima 02/07/2026
Diterbitkan 14/07/2026

***Kata Kunci*:**

Patient Safety,
ICU/NICU,
Invasive Procedures,
Infection Prevention,
Nurse Competency,
Healthcare-Associated Infections,
Aseptic Technique,
Hand Hygiene

ABSTRAK

Patient safety is a fundamental principle of modern healthcare, particularly in intensive care settings where critically ill patients are at heightened risk of healthcare-associated infections (HAIs) arising from frequent invasive procedures. Healthcare workers in intensive care units (ICUs) and neonatal intensive care units (NICUs) require periodic competency enhancement to ensure consistent, evidence-based implementation of patient safety principles. This community service activity aimed to improve the knowledge and competency of ICU and NICU healthcare workers at Ratu Mas Hospital, Binjai, in implementing patient safety principles, with particular emphasis on infection prevention during invasive procedures. A multimodal educational approach was employed, comprising didactic lectures, interactive discussions, procedure demonstrations, and knowledge evaluation using standardized pre-test and post-test instruments consisting of 15 multiple-choice questions covering hand hygiene, aseptic technique, and infection prevention in invasive procedures. The training was conducted on October 28–29, 2025, with 45 participants including ICU nurses, NICU nurses, and other clinical staff. Evaluation results demonstrated significant improvements in mean knowledge scores across all assessed domains: hand hygiene increased from 58.4 to 85.6 (+27.2 points); aseptic technique from 56.8 to 83.7 (+26.9 points); and infection prevention in invasive procedures from 61.2 to 87.4 (+26.2 points), yielding an overall mean improvement from 58.8 to 85.6 (+26.8 points). The training proved effective in enhancing healthcare workers' knowledge and should be delivered on a regular basis as an integral component of quality improvement and patient safety culture development in ICU and NICU settings. To translate these knowledge gains into sustained clinical practice, the institution is recommended to implement periodic hand hygiene audits, regular supervision, observational assessment of aseptic technique, and continuous quality improvement initiatives to sustain the patient safety culture.

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1. INTRODUCTION

Patient safety is a fundamental principle of modern healthcare systems, encompassing systematic measures to prevent patient harm, medical errors, infections, and adverse events throughout the care process. According to Indonesian Ministry of Health Regulation No. 11 of 2017 on Patient Safety, patient safety is defined as a system designed to render patient care safer through risk assessment, identification and management of risks, incident reporting and analysis, and implementation of solutions that minimize risk and prevent harm [1]. At the global level, the World Health Organization (WHO) estimates that one in every ten patients experiences an adverse event during the receipt of healthcare services, the majority of which are preventable [2].

Healthcare-associated infections (HAIs) represent one of the most significant threats to patient safety, particularly in intensive care settings. According to the European Centre for Disease Prevention and Control (ECDC), HAIs affect approximately 3.5 million patients annually across Europe, with considerable associated mortality [3]. In Indonesia, data from the Ministry of Health indicate that nosocomial infection rates in hospitals remain a serious challenge requiring systematic and evidence-based interventions [1]. ICU and NICU environments carry the highest risk of HAIs due to the clinical complexity of patient conditions, the intensity of invasive procedures performed, and the extensive use of medical devices that may serve as vectors for pathogenic microorganism transmission [4].

Patients admitted to the ICU are typically in critical condition, with compromised immune function, and frequently require invasive procedures such as central venous catheter insertion, urinary catheterization, mechanical ventilation, and invasive hemodynamic monitoring. These procedures inherently breach natural host defenses and create portals of entry for microorganisms [5]. Meta-analytic evidence consistently demonstrates that central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), and ventilator-associated pneumonia (VAP) represent the most prevalent infectious complications in ICU settings, associated with substantial morbidity and mortality [6]. In the NICU environment, infection risk is further compounded by the immunological immaturity of neonates—particularly premature infants—who are highly susceptible to CLABSI and opportunistic infections [7].

The WHO emphasizes the primacy of hand hygiene through the Five Moments for Hand Hygiene framework as the most cost-effective single intervention for preventing HAIs and interrupting pathogen transmission [8]. The Centers for Disease Control and Prevention (CDC) has published comprehensive evidence-based guidelines for the prevention of intravascular catheter-related infections, emphasizing healthcare worker education, strict aseptic technique, and care bundle strategies for catheter insertion and maintenance [9]. The successful implementation of these guidelines requires competent healthcare professionals who are able to internalize patient safety principles and apply them consistently in daily clinical practice [10].

Ratu Mas Hospital in Binjai, North Sumatra, operates active ICU and NICU units serving critically ill patients from Binjai and surrounding regions. A training needs assessment identified that nurses and medical staff in the intensive care units required competency reinforcement in the application of patient safety principles, specifically regarding hand hygiene, aseptic technique, and infection prevention practices in invasive procedures. This competency gap reflects a systemic need that must be addressed through applied, evidence-based training to establish and sustain a robust patient safety culture [11]. Based on this identified need, a community service training program on patient safety was designed and implemented in the ICU and NICU of Ratu Mas Hospital, focusing on the enhancement of nursing competency in infection prevention for invasive procedures. This initiative aimed to improve healthcare workers' knowledge, strengthen the application of aseptic technique and hand hygiene practices, and foster the development of a consistent and sustainable patient safety culture within the intensive care environment.

2. METHODS

2.1 Setting and Timeline

This community service training activity was conducted at Ratu Mas Hospital, Binjai, North Sumatra, on October 28–29, 2025. Ratu Mas Hospital operates active ICU and NICU units providing critical care services to patients from Binjai and its surrounding areas. The selection of this institution was based on the identified need to strengthen healthcare worker competency in the intensive care setting and the institution's readiness to support the implementation of the training program.

2.2 Participants

The target population comprised nurses and medical staff assigned to the ICU and NICU at Ratu Mas Hospital. A total of 45 participants attended the training, including ICU nurses, NICU nurses, and other clinical staff directly involved in the care of critically ill patients and the performance of invasive procedures. All participants were present and engaged in the full two-day training program.

2.3 Program Structure

The training program was organized into three sequential phases: preparation, implementation, and evaluation.

1) Preparation Phase.

The preparation phase included coordination with the management of Ratu Mas Hospital to establish the training schedule, venue, and participant list; development of evidence-based training materials incorporating current clinical guidelines; construction and review of the evaluation instruments (pre-test and post-test); and preparation of educational media including training modules, presentation slides, and procedure demonstration equipment.

2) Implementation Phase.

The training was conducted over two days, with a total duration of ten hours. The educational methods employed included: (a) didactic lectures to convey foundational concepts of patient safety, infection risks associated with invasive procedures, and WHO- and CDC-based infection prevention guidelines; (b) interactive discussions to elicit participants' experiences and challenges in daily clinical practice within the ICU and NICU; (c) procedure demonstrations to reinforce the practical application of WHO's Five Moments for Hand Hygiene, aseptic technique in invasive procedures, and correct use of PPE; and (d) question-and-answer sessions for clarification and in-depth exploration of the training content.

3) Evaluation Phase.

Consistent with the scope of this community service activity, evaluation was intentionally restricted to the assessment of participants' knowledge gains, measured through standardized pre-test and post-test instruments. Each instrument comprised 15 multiple-choice questions with four answer options and covered three assessment domains: hand hygiene comprehension (5 items), aseptic technique comprehension (5 items), and infection prevention in invasive procedures (5 items). Scores were calculated using the formula: Score = (Number of correct answers / 15) × 100, and the effectiveness of the training was determined by comparing mean post-test scores against pre-test scores across all domains. It should be noted that direct observation of clinical practice, hand hygiene compliance audits, behavioral evaluation, and long-term monitoring of practice change were not performed within the present activity. These dimensions represent acknowledged limitations of the current community service scope and are recommended as follow-up evaluations to comprehensively verify the translation of knowledge into sustained clinical behavior.

2.4 Training Content

The training curriculum was designed comprehensively and covered the following topics:

1. Fundamental concepts of patient safety and patient safety goals in accordance with national and international standards;
2. Infection prevention and control based on the WHO Patient Safety Framework;
3. Hand hygiene based on the WHO Five Moments for Hand Hygiene;

4. Aseptic technique in invasive procedures;
5. Appropriate selection and use of personal protective equipment (PPE);
6. Infection prevention for peripheral intravenous catheter insertion and maintenance;
7. Prevention of CAUTI in urinary catheter insertion and maintenance;
8. Safety principles for airway suctioning and VAP prevention in mechanically ventilated patients;
9. CLABSI prevention strategies for NICU patients; and
10. Documentation and reporting of patient safety-related events.

3. RESULTS AND DISCUSSION

3.1 Program Implementation

The patient safety training program was successfully conducted over two days—October 28–29, 2025 at Ratu Mas Hospital, Binjai. All 45 participants, comprising ICU nurses, NICU nurses, and other clinical staff, completed the full program sequence, encompassing the pre-test, instructional sessions, interactive discussions, procedure demonstrations, and the post-test. The high attendance rate and active engagement observed throughout the training reflected the healthcare workers' motivation and commitment to competency development in patient safety.

3.2 Pre-Test and Post-Test Evaluation Results

Evaluation results demonstrated significant improvements in participant knowledge scores across all three assessed domains following the training. Mean pre-test and post-test scores are presented in Table 1.

Table1. Pre-Test and Post-Test Evaluation Results of Patient Safety Training Participants, ICU and NICU, Ratu Mas Hospital, 2025

Assessment Domain	Mean Pre-Test Score	Mean Post-Test Score	Improvement
Hand Hygiene Comprehension	58.4	85.6	Increased (↑ 27.2 points)
Aseptic Technique Comprehension	56.8	83.7	Increased (↑ 26.9 points)
Infection Prevention in Invasive Procedures	61.2	87.4	Increased (↑ 26.2 points)
Overall Mean	58.8	85.6	Increased (↑ 26.8 points)

Source: Primary data from community service activity, October 2025

3.3 Discussion

As demonstrated in Table 1, all assessed knowledge domains showed meaningful improvement following the training intervention. The overall mean score increased from 58.8 (adequate category) to 85.6 (good category), representing an absolute improvement of 26.8 points. This substantial gain indicates that the two-day patient safety training program, employing a multimodal approach combining didactic lectures, interactive discussions, and procedure demonstrations, was effective in enhancing the knowledge of healthcare workers in the intensive care setting. These findings are consistent with a growing body of evidence demonstrating that structured, competency-based training significantly improves nurses' knowledge and adherence to infection

prevention procedures [11, 12].

The improvement in hand hygiene comprehension (from 58.4 to 85.6; ↑ 27.2 points) represents a particularly important clinical gain. Hand hygiene is universally recognized as the single most effective and cost-efficient intervention for preventing microorganism transmission and reducing HAI rates in healthcare settings [8]. The WHO Five Moments for Hand Hygiene framework delineates five critical moments for hand decontamination: before patient contact, before aseptic procedures, after exposure risk to body fluids, after patient contact, and after contact with the patient's immediate environment [8]. The internalization and consistent application of this framework by ICU and NICU nurses is of paramount importance given the high frequency of healthcare worker contact with critically ill patients and their potentially contaminated environments. Evidence from Allegranzi et al. (2013) demonstrated that improvements in hand hygiene compliance through comprehensive training programs can reduce HAI rates by up to 50% [13].

Figure 1. Practical demonstration of infection prevention and control (IPC) procedures in the ICU/NICU training session

The domain of aseptic technique also exhibited significant improvement (from 56.8 to 83.7; ↑ 26.9 points). Aseptic technique is an essential component of all invasive procedures performed in ICU and NICU settings, including intravascular catheter insertion, urinary catheterization, airway suctioning, and central vascular access. CDC guidelines for the prevention of intravascular catheter-related infections emphasize the importance of healthcare worker education, adherence to correct insertion procedures employing maximal sterile barrier precautions, and care bundle strategies for catheter maintenance and surveillance [9]. A strong foundation in aseptic technique further constitutes a prerequisite for the implementation of evidence-based nursing practice within the intensive care environment [14].

The greatest absolute improvement was observed in the domain of infection prevention in invasive procedures (from 61.2 to 87.4; ↑ 26.2 points). This finding indicates that the training content was highly relevant to participants' practical daily needs as nurses routinely performing invasive procedures. In the NICU setting, the CDC recommends a comprehensive CLABSI prevention strategy encompassing the minimization of central line manipulation, prompt removal of catheters when no longer clinically indicated, implementation of integrated care bundle approaches, and rigorous surveillance for early signs of infection in vulnerable neonates [7]. Knowledge of these procedure-specific infection prevention protocols constitutes an essential competency for NICU nurses in protecting neonatal patients from life-threatening infectious complications [15].

Collectively, these results underscore the contribution of this training activity to the strengthening of patient safety culture at Ratu Mas Hospital and its alignment with international quality frameworks. Within the WHO Global Patient Safety Action Plan 2021–2030 and the broader WHO Patient Safety Framework, sustainable safety outcomes cannot be achieved through regulatory mandates alone; they require shared institutional commitment, continuous education, and reporting systems that enable organizational learning from incidents and near-misses [2]. Situating this training within a hospital-wide infection prevention program and a

continuous quality improvement (CQI) cycle is therefore essential: periodic hand hygiene compliance audits, direct observational assessment of aseptic technique, and structured supervisory nursing constitute the mechanisms through which knowledge gains are converted into stable behavioral change and, ultimately, into reduced HAI incidence [11, 13, 16]. Competency maintenance likewise depends on recurrent refresher training, mentorship by senior clinical staff, and periodic reassessment, so that evidence-based standards remain embedded in daily practice [10, 14]. Beyond acquiring technical knowledge, participants reinforced the understanding that every invasive procedure must be performed safely, in accordance with evidence-based standards, and meticulously documented as an integral component of the clinical and ethical responsibilities of healthcare workers [10].

Several limitations of this activity warrant acknowledgment. As indicated in the Methods, evaluation was confined to a written knowledge instrument; practical procedural skills, hand hygiene compliance, actual clinical behavior, and long-term sustainability were not directly assessed. Consequently, the observed knowledge gains should be interpreted as a necessary but not sufficient condition for improved patient outcomes. To maximize the long-term impact of this initiative and to safeguard the sustainability of patient safety culture, Ratu Mas Hospital is strongly encouraged to complement the current program with periodic hand hygiene compliance audits, direct observation of aseptic technique during invasive procedures, supervision of invasive procedures by senior nursing staff, and systematic monitoring of patient safety quality indicators, including HAI incidence rates in the ICU and NICU.

4. CONCLUSION

The patient safety training program conducted for ICU and NICU nurses and clinical staff at Ratu Mas Hospital, Binjai, demonstrated clear benefit in enhancing the competency of healthcare workers involved in the care of critically ill patients. Structured, evidence-based education combining didactic instruction, interactive discussion, and procedure demonstration produced meaningful improvements across the core domains of hand hygiene, aseptic technique, and infection prevention in invasive procedures, thereby strengthening a key pillar of the hospital's patient safety culture. For the institution, the activity carries important implications: it reinforces adherence to WHO and CDC infection prevention standards, supports the mitigation of healthcare-associated infections in the highest-risk clinical areas, and provides a replicable model for competency development that can be extended to other units. Consistent with the WHO Patient Safety Framework and continuous quality improvement principles, Ratu Mas Hospital is encouraged to institutionalize this initiative through periodic patient safety training, regular hand hygiene compliance audits, observational assessment of aseptic practice, structured supervisory nursing, and systematic monitoring of patient safety indicators, so that gains in individual competency translate into sustainable, system-level improvements in the quality and safety of patient care.

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