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Research Article

# Preventing Ventilator Associated Pneumonia (VAP) in the Neonatal Intensive Care Unit and Pediatric Intensive Care Unit

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ABSTRACT

Neonates and children with respiratory distress who require mechanical ventilation have a higher risk of developing VAP. Therefore, VAP prevention should be considered one of the most important issues in NICU and PICU care. This study aims to identify VAP prevention efforts in the NICU and PICU. The research design used in this study was descriptive qualitative. This study's sampling technique used the Focus Group Discussion (FGD) with six nurse participants who worked in the NICU and PICU using a semi structured interview format. Data were analyzed using thematic analysis. Three main themes describe implementing VAP prevention efforts in the NICU and PICU. The first theme concerns VAP prevention efforts that are still not optimal. Some VAP prevention measures implemented include hand washing, gloves usage, sterile suctioning techniques, head up 30-45 degrees, and oral hygiene. At the same time, other actions have not been routinely carried out. The second theme is the existence of barriers to implementing VAP prevention, and the third theme is related to the need to increase the capacity of nurses and support facilities. Nurses revealed that the implementation of the VAP prevention program in the NICU and PICU had not run optimally, one of which could be caused by limited infrastructure and nurses' competence. Thus, it is necessary to increase the knowledge and skills of nurses related to VAP and provide adequate infrastructure.

## INTRODUCTION

Healthcare-associated infections (HAIs) pose a significant threat to patients undergoing hospital care. HAIs are infections acquired by patients while they are undergoing treatment in a hospital. The incidence of HAIs is found to be higher in patients on mechanical ventilation or respiratory support who are being treated in the ICU. The Centres for Disease Control and Prevention (CDC) reports that approximately 32% of healthcare-associated infections (HAIs) are associated with the use of mechanical ventilation, leading to ventilator-associated pneumonia (VAP) (Center for Dissease Control and Prevention (CDC), 2021; Zaragoza et al., 2020).

Ventilator-associated pneumonia (VAP) is defined by the Centres for Disease Control and Prevention (CDC) as worsening gas exchange in patients on mechanical ventilation that becomes apparent after 48 hours. VAP may exhibit at least three of the following criteria: unstable temperature without a clear cause, changes in respiratory secretion characteristics, and bradycardia or tachycardia (Center for Dissease Control and Prevention (CDC), 2021).

The International Nosocomial Infection Control Consortium (INICC) reports that the incidence of VAP reaches 13.6 per 1,000 ventilators per day. In Asian countries, the incidence of VAP ranges from 3.5 to 46 per 1,000 ventilators per day. Globally, the prevalence of VAP is 12.6%, with rates of 13.5% in the United States, 19.4% in Europe, 13.8% in Latin America, and 16% in South Asia (Aziz et al., 2020).

Based on several research findings, the incidence of VAP in Indonesia shows a high rate. A study conducted by Khayati et al. (2018) in one of the hospital's ICUs showed a VAP incidence of 36.8%. A study conducted by Rahmawati (2014) in another hospital's ICU also reported a pneumonia incidence of 42% among ICU patients, with 86.8% of those patients dying. The mortality rate for VAP patients ranges from 24% to 50% and can increase to 76% if the infection is caused by multidrug-resistant microorganisms (Noorifard et al., 2020). The mortality risk for VAP patients is twice as high as for patients without VAP (Silva & Junior, 2015). Studies by Osman et al. (2020) and Ismail and Zahran (2015) indicate that VAP is a cause of increased morbidity and mortality rates among ICU patients. Several studies have shown that neonates and children on ventilators have a higher risk of developing VAP compared to older individuals.

Several studies have explored VAP in adult patients, but few have focused on neonates and children. However, VAP is the second most common nosocomial infection in patients in the Neonatal Intensive Care Unit (NICU) and Pediatric Intensive Care Unit (PICU) (Azab et al., 2015; Hadi et al., 2020). Respiratory Distress Syndrome (RDS) is a common diagnosis in neonates with prematurity and low birth weight who require respiratory support. Additionally, bronchopneumonia is a common condition in children who also require respiratory support. To assist neonates and children with these conditions, respiratory support, including intubation and mechanical ventilation, is essential. Although there has been an increase in the survival rate of premature neonates and children with mechanical ventilation and advanced technology in NICU and PICU care, the prolonged use of mechanical ventilation can lead to the development of VAP. Therefore, VAP in premature neonates and children is an important issue (Abou Zed & Mohammed, 2019).

Nurses in the ICU play a crucial role in preventing VAP. VAP prevention should be considered a key issue in critical care and a core component of intensive care unit performance (Joint Commission on the Accreditation of Healthcare Organizations,

2016). Several evidence-based guidelines and reviews on VAP prevention have been published since this became a significant issue in recent years (Speck et al., 2016). These VAP prevention guidelines are in the form of a standard operating procedure known as the VAP Bundle (VAPb). Bundles are a collection of processes required for effective and safe care for patients with specific conditions and high risks.

Several published VAP bundles summarise effective interventions for infection control practices and recommendations for preventing VAP. However, some of these bundles are now nearly 10 years old and do not incorporate the latest evidence-based practices in line with scientific advancements. Among them, in 2005 and updated in 2013, the CDC published a VAP bundle that has been widely used by ICUs, including ICUs in Indonesian hospitals, as outlined in Ministry of Health Regulation No. 27 of 2017 on guidelines for infection prevention and control in healthcare facilities (Ministry of Health of the Republic of Indonesia, 2017). Additionally, there are guidelines from the Infectious Diseases Society of America/The American Thoracic Society (IDSA/ATS) and the National Healthcare Safety Network regarding the VAP bundle (Speck et al., 2016).

Several studies have shown that the VAP bundle has been proven to reduce the incidence of VAP, lower mortality rates, improve patient outcomes, shorten hospital stays, and reduce healthcare costs when implemented effectively (Azab et al., 2015; Ferreira et al., 2016; Samra et al., 2017; Zaiton & Elhanafy, 2015). Although access to the VAP bundle is available, its implementation remains suboptimal due to varying levels of knowledge among healthcare providers (Rahma & Ismail, 2019).

Although efforts to prevent Ventilator-Associated Pneumonia (VAP) have been extensively studied quantitatively, most studies focus on the effectiveness of the bundle or compliance with protocols. However, there is limited exploration of how VAP prevention practices are implemented in the field, particularly from the perspective of healthcare workers in NICUs and PICUs. Additionally, specific VAP prevention guidelines applicable to NICU and PICU settings remain limited.

This gap is important because the success of implementation is greatly influenced by contextual factors such as work culture, workload, and resource availability. This qualitative study presents novelty by exploring the direct experiences of healthcare workers, particularly nurses, to identify challenges and adaptive strategies in VAP prevention. The results are expected to serve as a basis for developing more relevant and applicable interventions in neonatal and pediatric intensive care settings. Therefore, this study aims to identify efforts to prevent ventilator-associated pneumonia (VAP) in neonatal intensive care units (NICUs) and pediatric intensive care units (PICUs).

## METHOD

The research design used in this study was qualitative descriptive. The research was conducted in the NICU and PICU of a regional general hospital in the Bandung area of West Java Province. The sampling technique used in this study was purposive sampling, with the inclusion criteria for participants being nurses working in the NICU/PICU, having at least one year of work experience in the NICU/PICU, having participated in infection prevention training, holding a minimum of an Associate Degree in Nursing, and being willing to participate in the study. The study included six participants, consisting of three nurses from the NICU and three from the PICU.

Data collection was conducted using the focus group discussion (FGD) technique with a semi-structured interview format and

field notes. Data were analyzed using Braun and Clarke's thematic analysis method, which includes the following steps: verbatim transcription of interview data; in-depth reading and understanding of the data; coding the data, identifying patterns and main themes; identifying core themes that describe family experiences; and interpreting the results by linking the findings to theory and previous research (Braun & V.Clarke, 2006; Nowell, 2017).

In this data analysis, the principle of trustworthiness was applied, encompassing aspects of credibility, transferability, dependability, and confirmability. This approach was adopted to ensure that research findings are reliable and accurately reflect the experiences of nurses. By adhering to these principles, qualitative data analysis was conducted in-depth and systematically, thereby identifying key themes in understanding nurses' experiences in preventing VAP in the NICU and PICU.

Before conducting the research, the researcher obtained ethical approval from the Health Research Ethics Committee of the School of Nursing (STIKep) PPNI West Java, as indicated in letter number III/084/KEPK-SLE/STIKEP/PPNI/JABAR/X/2024. The researchers then obtained research permission from the hospital, as indicated by letter number 070/6855/DR.00-RS.

## RESULTS

This study involved six nurses working in pediatric intensive care units, comprising three nurses from the Neonatal Intensive Care Unit (NICU) and three nurses from the Pediatric Intensive Care Unit (PICU). The following are the demographic data of the participants in this study.

**Table 1 Demographic Characteristics of Participants (n = 6)**

| No. | Characteristics | Frequency (*f*) | Percentage (%) |
|---|---|---|---|
| 1. | Age | | |
| | 31-40 Years Old | 2 | 33,3 |
| | 41-50 Years Old | 4 | 66,7 |
| 2. | Gender | | |
| | Male | 1 | 16,7 |
| | Female | 5 | 83,3 |
| 3. | Work experience in hospitals | | |
| | <10 years | 0 | 0 |
| | >10 years | 6 | 100 |
| 4. | Work experience in NICU/PICU | | |
| | 3-5 years | 2 | 33,3 |
| | 6-10 years | 2 | 33,3 |
| | >10 years | 2 | 33,4 |
| 5. | Level of education | | |
| | D3 Nursing | 3 | 50,0 |
| | S1 Nursing Profession | 3 | 50,0 |
| 6. | Experience participating in VAP workshops | | |
| | Never | 3 | 50,0 |
| | Yes | 3 | 50,0 |

Demographic data analysis in Table 1 reveals that the majority of participants were aged between 41 and 50 years, with a slight female predominance. All participants had more than 10 years of work experience in hospitals, but their work experience in NICUs and PICUs varied, ranging from 3 years to more than 10 years.

In terms of education, some participants were graduates of the Nursing Profession program, while others were graduates of the Diploma III Nursing program. This difference in educational levels provides diverse perspectives on clinical practices for preventing VAP. The most striking difference was found in the experience of attending VAP prevention workshops. All participants from the NICU stated that they had never attended a workshop related to VAP prevention, while all participants from the PICU admitted to having attended similar training. It indicates a gap in access

to training or professional capacity building between the two units.

Through thematic analysis of the FGD data, three main themes emerged that describe the implementation of VAP prevention efforts in the NICU and PICU: VAP prevention efforts are not yet optimal, barriers to implementing VAP prevention, and the need to improve nurse capacity and facility support.

**Theme 1: VAP prevention efforts are not yet optimal**

Generally, all nurses are already familiar with the concept of VAP.

"... VAP stands for Ventilator-Associated Pneumonia, which refers to pneumonia caused by the use of a ventilator, typically occurring three or four days after ventilator placement, with symptoms and signs of pneumonia that can be identified through auscultation, chest X-rays, and further testing via sputum culture..." (P4)

"... VAP is closely related to nurses' adherence to the VAP bundle. VAP occurs when nurses do not adhere to the VAP bundle because the program already exists..." (P5)

Participants explained that some VAP prevention practices are routinely performed, such as handwashing before and after procedures, glove use, sterile technique during suctioning, positioning the head of the bed at 30–45 degrees, and providing oral hygiene to patients. However, these actions are not yet performed comprehensively and consistently, depending on individual habits and on-duty conditions.

"... In the NICU, positioning is already in place, but sedation is rarely administered unless the patient exhibits signs of struggling. Additionally, we usually wash our hands. Regarding suctioning, the room already uses closed suction. As for cleaning the circuit, it is not done routinely; when the patient has been there for more than seven days, the circuit is not replaced but continues to be used..." (P1)

"... In the PICU, hand washing is performed at a rate of approximately 99%, and suctioning is also performed at a rate of around 99%. However, there is still a mix between closed suction and open suction. However, oral hygiene is rarely performed due to constraints with disposable equipment. It is rarely done every 4 hours, but rather every 8 hours per shift. Additionally, VAP bundle education has not been conducted by PPI or staff who have undergone training. Regarding patient positioning, it is adjusted based on the patient's condition, and sedation also depends on the patient's clinical condition..." (P6)

"…Ventilator circuit replacement every 7 days is rarely done, often forgotten, with challenges including busyness due to the high number of patients. In the NICU, oral hygiene uses warm water or warmed NaCl or breast milk, and in the NICU, oral hygiene is done every 3 hours, especially for patients with hypersalivation..." (P1)

Meanwhile, the use of sedation is infrequent and depends on the patient's condition. Additionally, prophylaxis for deep vein thrombosis (DVT) and peptic ulcer disease is only administered to high-risk patients. Regarding the monitoring of endotracheal tube cuff pressure, it is rarely done routinely and is only monitored at the initial placement. Similarly, ventilator circuit replacement is not performed routinely. For checks related to the potential for extubation or ventilator removal in patients where it is feasible, this is done by the physician.

"…Prophylaxis for DVT and peptic ulcer diseases is only administered to high-risk patients. Monitoring of endotracheal tube cuff pressure is not performed regularly, only at the time of initial placement..." (P2)

"... Daily evaluation of the potential for extubation or ventilator removal in patients is performed by a doctor..." (P5)

**Theme 2: Barriers to the implementation of VAP prevention**

The implementation of the VAP prevention program is considered to be suboptimal. Nurses revealed that there are still barriers in terms of infrastructure and human resource readiness. The lack of standard oral care equipment, limited personal protective equipment, and the unavailability of easily accessible written guidelines are the main obstacles in the field. Additionally, some nurses also stated that they have not received specialised training related to VAP prevention.

"... Sometimes not all tools are available, so we just adapt, as long as the patient remains clean and comfortable..." (P3)

"... The shortage of human resources means that the nurse-to-patient ratio for ventilator-dependent patients should be 1:1. However, currently there are still too many patients, and nurses' competencies are insufficient because specialised training on the VAP bundle is still limited, with few having attended the training, so not everyone has been exposed to VAP bundle training…" (P1)

"…Infrastructure is still insufficient, for example, the availability of chlorhexidine for oral hygiene is limited, and the equipment for oral hygiene is not yet available…" (P4)

**Theme 3: Need for enhanced nursing capacity and facility support**

Most participants recognise the importance of nurses' roles in preventing VAP and expect regular training and adequate facilities to be provided so that the VAP prevention bundle can be implemented optimally. Some nurses also suggest regular supervision and monitoring to maintain consistency in the implementation of preventive measures.

"... If there were regular training or refresher courses, we might understand better and feel more confident..." (P3)

"... The training and socialisation so far have not been in-depth..." (P3)

"... The training I attended was related to general infection programs..." (P1)

"... Furthermore, training is still rare, especially in West Java, for competency improvement related to PICU training, one of which is the VAP bundle..." (P4)

"… Expanding knowledge and skills related to the VAP bundle is necessary for nurses working in intensive care units…" (P2)

"... Regular supervision and monitoring may also need to be implemented to monitor the implementation of VAP prevention measures…" (P5)

**DISCUSSION**

The results of this study reveal that the implementation of Ventilator-Associated Pneumonia (VAP) prevention measures in the Neonatal Intensive Care Unit (NICU) and Pediatric Intensive Care Unit (PICU) has not been fully optimised. Based on the results of the focus group discussions (FGD) conducted with nurses in both intensive care units, it was identified that while some preventive measures have been implemented in daily practice, their implementation on the ground remains incomplete and inconsistent.

Standard preventive measures carried out by nurses include hand washing before and after procedures, wearing gloves when caring for patients, using sterile techniques during suctioning, adjusting the head of the bed to a 30–45-degree angle to minimise the risk of aspiration, and performing routine oral hygiene for patients on ventilators. However, the implementation of these protocols still depends on the individual habits of nurses, and not all nurses consistently carry out all

components of the recommended prevention protocols. Situational factors, such as high workloads and time constraints during shifts, also influence the comprehensive implementation of VAP prevention.

Although most participants had an understanding of the basic concepts of VAP and its urgency as a severe nosocomial infection, the level of implementation of preventive practices did not fully reflect this level of knowledge. These findings are consistent with the research of Nurhayati and Priambodo (2018) and Rahma and Ismail (2019), who stated that although nurses' knowledge is a key element in nosocomial infection prevention efforts, the success of implementation is still greatly influenced by other supporting factors, including the availability of facilities, clinical leadership, and effective monitoring systems.

Participants in this study also identified several significant challenges they faced in implementing the VAP prevention program. One of the most frequently mentioned barriers was the limitation of facilities and infrastructure, such as the lack of standard-compliant oral care tools, insufficient supplies of personal protective equipment such as gloves and sterile masks, and the absence of written guidelines or standard operating procedures (SOPs) that are easily accessible and used as references in daily practice. Additionally, the lack of regular training or refresher courses on VAP is another important factor hindering the strengthening of nurses' capacity to carry out prevention efforts (Hutagaol et al., 2021).

Another finding that emerged from the FGD discussion was the difference in training experiences between nurses in the NICU and PICU units. All participants from the PICU unit stated that they had attended special training on VAP prevention, while participants from the NICU unit reported that they had never received similar training. This disparity indicates a gap in human resource capacity development between units that needs to be addressed immediately through more equitable training policies. Training has proven to be an important intervention that can enhance nurses' knowledge, skills, and adherence to VAP prevention protocols (Azab et al., 2015; Khalifa & Eldin, 2020; Radhakrishnan et al., 2021).

Additionally, there are challenges in establishing a VAP diagnosis, particularly in neonatal patients. Nurses reported that the process of diagnosing VAP in neonates often takes longer and is not always based on uniform indicators. This uncertainty in diagnosis contributes to inconsistencies in prevention efforts, as not all nurses are confident whether the patients they care for fall into the high-risk category for VAP.

Nurses themselves recognise that they play a central role in preventing VAP, as they are the healthcare professionals who are closest to and interact with patients most frequently. Nurses are responsible for implementing daily care practices that directly reduce infection risk, such as maintaining oral hygiene, monitoring patient body position, ensuring ventilator equipment functions properly, and performing safe and sterile suctioning procedures. Several studies have demonstrated that nurses' active involvement in implementing VAP prevention protocols, such as the VAP bundle, significantly contributes to reducing infection rates, shortening the duration of ventilator use, and accelerating patient recovery (Azab et al., 2015; Ladbrook et al., 2019, 2021; Zaiton & Elhanafy, 2015).

Research by Ladbrook et al. (2019) demonstrates that the consistent implementation of the VAP bundle can significantly reduce the incidence of VAP and has a positive impact on reducing antibiotic use, particularly in patients with

prolonged ventilator use. Similar findings were reported by Zaiton and Elhanafy (2015), who stated that the VAP prevention bundle also plays a crucial role in shortening patient hospital stays and improving overall patient safety.

In the context of the NICU, the use of mechanical ventilation for more than 48 hours significantly increases the risk of VAP. VAP in neonates often leads to prolonged hospitalization and increased healthcare costs. VAP is also strongly associated with prematurity, low birth weight (LBW), chronic lung disease, and long-term mechanical ventilation. One cited study noted that Gram-negative bacteria, particularly Klebsiella pneumoniae, are the most common pathogens found in neonatal VAP cases. Additionally, the use of empirical antibiotic therapy in VAP cases remains high, which also has implications for the emergence of antimicrobial resistance (Azab et al., 2015).

In this study, most nurses stated that the success of VAP prevention requires strong systemic support. They emphasized the importance of routine supervision, monitoring of procedure implementation, and regular evaluations to ensure that standards are carried out effectively and prevent efforts from being undermined. Nurses also suggested that hospitals provide regular competency-based training and ensure the availability of adequate facilities and equipment to optimize the implementation of prevention protocols. This finding aligns with the results of Cazali et al. (2018), who reported that routine supervision is effective in enhancing nurses' adherence to the VAP bundle.

Systemic barriers, including an unfavourable nurse-to-patient ratio, the unavailability of oral care tools that meet standards, and the absence of practical documentation or procedural guidelines, were also identified as challenges in this study. These findings align with the results of Saodah's (2019) study, which suggests that low compliance with nosocomial infection prevention protocols is primarily due to structural limitations and a lack of organizational support.

Furthermore, this study emphasizes that infection prevention practices, such as VAP, cannot rely solely on individual nurse competence. Comprehensive interventions are necessary, including the availability of standardized written guidelines, monitoring and feedback systems, and the establishment of a patient safety culture within the workplace. As stated by Dosher et al. (2014), knowledge-based practices must be complemented by support systems that enable continuous implementation.

The theme of the need to enhance capacity and facilities in VAP prevention, as revealed by the FGD results, indicates nurses' awareness of the importance of their role in ensuring patient safety. This awareness serves as a crucial foundation for promoting continuous training interventions and systemic approaches that empower nurses to perform their roles optimally. In line with the views of Pun et al. (2019) interprofessional and participatory strategies that prioritize collaboration among healthcare workers and empower nurses can increase the effectiveness of infection prevention efforts in intensive care units.

## CONCLUSIONS AND RECOMMENDATION

The results of this study reveal that efforts to prevent Ventilator-Associated Pneumonia (VAP) in the NICU and PICU have not been fully implemented comprehensively and consistently. Some preventive measures that have been implemented include hand hygiene practices, the use of gloves, sterile techniques during suctioning, positioning the head of the bed at 30–45 degrees, and providing oral hygiene. Although these measures reflect important initial efforts,

their implementation has not been optimal. Nurses identified significant barriers to implementing VAP prevention, including limited infrastructure and inadequate knowledge and skills among nursing staff. This situation highlights a gap between existing standard operating procedures (SOPs) and field practices, which can compromise the effectiveness of infection prevention in intensive care units.

Based on these findings, several strategic efforts are recommended to improve the effectiveness of VAP prevention programs in NICUs and PICUs, including: 1) Enhancing nurses' competencies through regular training, evidence-based knowledge updates, and clinical simulation exercises related to VAP prevention; 2) Strengthening facility support systems, including the provision of personal protective equipment, oral hygiene tools, and suction instruments that meet standards; 3) Regular monitoring and evaluation of nurses' compliance with the VAP prevention bundle, accompanied by clinical supervision that supports learning; and 4) Developing a patient safety culture in the NICU and PICU environment, by encouraging interprofessional collaboration and responsive clinical leadership. These efforts are expected to strengthen the sustainable implementation of VAP prevention, thereby reducing the incidence of VAP and improving the quality of care in neonatal and pediatric intensive care units.

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