

Strategies To Improve Nurse Compliance With Ventilator-Associated Pneumonia Bundle Implementation In Intensive Care Units: A Scoping Review

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ABSTRACT

Background: Ventilator-associated pneumonia (VAP) remains a leading cause of morbidity and mortality among patients in intensive care units (ICUs). Nurses play a central role in preventing VAP through consistent implementation of evidence-based prevention bundles. Although VAP bundles are widely recommended, suboptimal adherence among nurses continues to contribute to high VAP incidence rates, highlighting the need for strategies that improve compliance. **Objective:** This scoping review aimed to identify and synthesize interventions designed to enhance nurse compliance with VAP bundle implementation in ICU settings. **Methods:** A scoping review was conducted using the Population-Concept-Context (PCC) framework, focusing on nurses, interventions to improve VAP bundle compliance, and ICU settings. Electronic databases—including PubMed, Cochrane Library, ProQuest, EBSCOhost, ScienceDirect, ClinicalKey, SAGE Journals, and Google Scholar—were searched for full-text articles published in English between 2016 and 2021. Study selection followed the PRISMA framework. Data were extracted, analyzed, and synthesized narratively. **Results:** From 945 identified records, eight studies met the inclusion criteria. The reviewed literature identified educational and training programs, experiential learning strategies, interprofessional collaboration, and real-time compliance monitoring dashboards as effective interventions to improve nurse adherence to VAP bundles. **Conclusion:** Multifaceted interventions, particularly continuous education supported by supervision and monitoring, are effective in enhancing nurse compliance with VAP bundle implementation. Sustained organizational support is essential to improve adherence and reduce VAP incidence in ICU settings.

Keywords: ventilator-associated pneumonia; VAP bundle; nurse compliance; intensive care unit; scoping review

I. INTRODUCTION

Healthcare-associated infections (HAIs) are a significant threat to hospital care patients. HAIs are infections acquired while patients 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 Centers for Disease Control and Prevention (CDC) reports that approximately 32% of HCAI cases are associated with the use of mechanical ventilation, leading to ventilator-associated pneumonia (VAP) (Center for Disease Control and Prevention (CDC), 2021; Zaragoza et al., 2020). Ventilator-associated pneumonia (VAP) is defined by the Centers for Disease Control and Prevention (CDC) as a deterioration in gas exchange in patients on mechanical ventilation that becomes apparent after 48 hours and meets at least three of the following criteria: unstable temperature without a clear cause, changes in respiratory secretion

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characteristics, and bradycardia or tachycardia (Center for Disease 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 reaches 12.6%, with 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 is high. A study by Budiono (2013) in one of the ICUs at the Central General Hospital showed a VAP incidence of 36.8%. A study conducted by Rahmawati (2014) in the same 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). Research by Osman et al. (2020) and Ismail and Zahran (2015) state that VAP is a cause of increased morbidity and mortality rates among ICU patients.

ICU nurses play a crucial role in preventing VAP. VAP prevention should be considered a critical issue in critical care and a core component of intensive care unit performance (Joint Commission on the Accreditation of Healthcare Organizations, 2005). Several evidence-based guidelines and reviews on VAP prevention have been published since this issue gained prominence recently (Speck et al., 2016). These guidelines for VAP prevention are in the form of operational standards 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-risk factors.

Some published VAP bundles summarize effective interventions for infection control practices and recommendations to prevent VAP. However, some of these bundles are over 10 years old and do not include 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, 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, reduce length of stay, and decrease healthcare costs when implemented effectively (Azab et al., 2015; Cooper & Haut, 2013; Ferreira et al., 2016; Morris et al., 2011; Samra

et al., 2017; Zaiton & Elhanafy, 2015). Although access to the VAP bundle is available, its implementation remains suboptimal, with varying levels of compliance (Al-Sayaghi, 2014).

The success of nurses' implementation of the VAP bundle in the ICU depends, among other things, on compliance with nursing actions (Sadli et al., 2017). Research conducted by Madhuvu et al. (2020) in two Australian ICUs also showed that nurses had poor knowledge and compliance with VAP prevention, aligns with the study by Aloush and Al-Rawajfa (2020), who conducted research in Jordan on nurses' adherence to the VAP bundle in the ICU, showing that 45.6% of nurses were non-compliant, 24.8% had weak adherence, and only 29.6% were compliant. The lack of nurses' knowledge about the VAP bundle can also be a barrier to adhering to guidelines or evidence-based practices related to the VAP bundle (Osti et al., 2017; Yeganeh et al., 2019), because nurses' knowledge is crucial for implementing guidelines to improve compliance in the VAP bundle (Hawsawi et al., 2017; Jahansefat et al., 2016).

Nurses also reported several barriers limiting the implementation of the VAP bundle. These barriers include lack of knowledge, lack of skills, lack of time, lack of guidance, workload, inadequate training, lack of clear policies and protocols, lack of facilities and infrastructure, lack of staff, and insufficient funding (Aloush, 2017; Aloush & Al-Rawajfa, 2020; Damayanti & Handiyani, 2021; Safdar et al., 2016).

Various research findings indicate that nurses have not implemented the VAP bundle optimally and still exhibit low compliance. Additionally, there are other barriers to implementing the VAP bundle. This results in suboptimal implementation of the VAP bundle, as evidenced by the persistently high incidence of VAP compared to the expected standard of 15% per 1,000 ventilator uses (Aziz et al., 2020). Meanwhile, the role of nurses in preventing VAP is crucial because most of the actions included in the VAP bundle are related to daily nursing care activities closely tied to the nurse's role as a care provider, manager, educator, coordinator, and evaluator (Ismail & Zahran, 2015; Osti et al., 2017). Therefore, interventions are needed to improve the ICU's implementation of the VAP bundle.

Research on nurses' compliance with the VAP bundle is important to identify factors influencing compliance levels and the effectiveness of various interventions that can be implemented. The results of this research serve as a basis for decision-making by ICU management in formulating policies and strategies to improve the quality of nursing care. With a deeper understanding of the factors influencing nurse compliance, developing education programs, training, and monitoring can be more targeted and effective. Various studies have shown that educational interventions, staff development programs, multidisciplinary intervention approaches, training, and other interventions can improve the ICU's implementation of the VAP bundle. These interventions are expected to reduce

the incidence of VAP in the ICU, improving the quality of care for patients in the ICU. Based on the background explanation, this study aims to identify various interventions to improve nurse compliance with implementing the VAP bundle in the ICU using the scoping review method.

II. METHOD

Study Design

This study employed a scoping review design to systematically map evidence on interventions aimed at improving nurse compliance with the ventilator-associated pneumonia (VAP) bundle in intensive care units (ICUs). A scoping review was chosen to comprehensively explore the breadth of concepts, intervention types, theoretical approaches, and evidence gaps related to this topic. The review was conducted in accordance with methodological guidance from the Joanna Briggs Institute (JBI) and reported following the PRISMA Extension for Scoping Reviews (PRISMA-ScR) to ensure transparency, reproducibility, and methodological rigor.

Review Question and Framework

The review addressed the following question: What interventions have been implemented to improve nurse adherence to the VAP bundle in ICU settings?

The Population-Concept-Context (PCC) framework guided the review: Population—nurses; Concept—interventions to enhance compliance with the VAP bundle; Context—ICU or critical care settings.

Sample and Eligibility Criteria

The sample consisted of peer-reviewed research articles that met the following inclusion criteria: (1) focused on nurses working in ICUs, (2) examined interventions to improve compliance or adherence to the VAP bundle, (3) published in English between 2016 and 2021, and (4) available in full text. Exclusion criteria included non-empirical publications (editorials, commentaries), studies unrelated to VAP bundle compliance, and articles conducted outside ICU contexts.

Search Strategy and Data Collection

A comprehensive literature search was conducted across multiple electronic databases, including the Cochrane Library, PubMed, ProQuest, EBSCOhost, ScienceDirect, ClinicalKey, SAGE Journals, and Google Scholar. Search terms were developed using Boolean operators and keywords related to nurses, interventions, compliance, VAP bundle, and ICU. The study selection process followed PRISMA-ScR recommendations and was documented using a PRISMA flow diagram. Two reviewers independently screened titles, abstracts, and full texts, with discrepancies resolved through discussion.

Instruments and Data Extraction

Data were extracted using a standardized extraction form adapted from JBI guidance. Extracted variables included author, publication year, country, study design, sample characteristics, type of intervention, implementation strategies, outcome measures, and key findings related to nurse compliance.

Data Analysis and Synthesis

Data were analyzed using a descriptive and thematic synthesis approach. Interventions were categorized into thematic groups (e.g., education and training, experiential learning, interprofessional collaboration, monitoring systems), and findings were narratively synthesized to highlight patterns, similarities, and research gaps.

Ethical Considerations

Ethical approval was not required, as this study analyzed data from publicly available published literature. Ethical standards were upheld through accurate citation, transparent reporting, and adherence to recognized scoping review guidelines.

III. RESULTS

The researchers searched for scientific publications in this scoping review using data from several electronic databases: Cochrane Library, ProQuest, PubMed, EBSCOhost, ScienceDirect, Clinical Key, SAGE Journals, and Google Scholar. The search yielded 945 articles. These articles were then checked for duplicates, resulting in 906 unique articles. A screening was then conducted based on full-text availability and publication year (2016-2021), resulting in 750 articles excluded from the review process. From the 156 articles that passed the screening, further screening was conducted based on inclusion and exclusion criteria, resulting in 136 articles being excluded from the review process because their objectives did not align with the research objectives and were not related to interventions aimed at improving nurses' adherence to the VAP bundle in the ICU. Based on the screening results, eight articles met the established inclusion criteria and were subsequently reviewed.

Across the reviewed studies, interventions to prevent Ventilator-Associated Pneumonia (VAP) can be thematically categorized into three main approaches: education-only, multimodal educational strategies, and digital or technology-supported interventions, all of which demonstrated varying degrees of effectiveness in improving compliance and reducing VAP incidence.

Education-only interventions primarily focused on structured lectures, short training sessions, and continuous education programs targeting ICU nurses. Studies implementing this approach consistently reported significant improvements in

nurses' compliance with VAP bundle components and a corresponding reduction in VAP incidence (Branco et al., 2020; Mogyoródi et al., 2016). However, while education alone was effective in increasing knowledge and adherence, its impact on long-term sustainability appeared limited without ongoing reinforcement or system-level support.

Multimodal interventions, combining education with checklists, audits, experiential learning, simulation, and interprofessional collaboration, demonstrated more robust and sustained outcomes. Quasi-experimental and longitudinal studies showed substantial reductions in VAP incidence, shortened duration of mechanical ventilation, and improved clinical outcomes when education was integrated with compliance monitoring and team-based strategies (Radhakrishnan et al., 2021; Adiyeké et al., 2021; Michelángelo et al., 2020; McBeth et al., 2018). These findings highlight that behavioral change in complex ICU environments is more effectively achieved through interactive learning and multidisciplinary engagement rather than education alone.

Digital and technology-supported interventions, such as real-time compliance dashboards and online training platforms, yielded the most sustained improvements in both compliance and VAP reduction. Studies incorporating digital monitoring systems reported marked increases in bundle adherence and long-term reductions in VAP incidence, exceeding 50% in some settings (Talbot et al., 2016; Álvarez-Lerma et al., 2018). Real-time feedback and automated performance visualization appear to enhance accountability, facilitate timely corrective actions, and support continuous quality improvement.

Table 1 Data Analysis Results

No.	Title and Author	Purpose	Population/Sample	Method	Intervention	Outcome	Results and Conclusions
1.	Effect of Training and Checklist Based Use of Ventilator Associated Pneumonia (VAP) Prevention Bundle Protocol on Patient Outcome: A Tertiary Care Centre Study (Radhakrishnan et al., 2021)	This study aims to identify the effectiveness of training and the use of checklists in implementing the VAP bundle, which aims to improve nurse compliance and enhance the quality of patient care.	This study's sample consisted of 50 patients on ventilators at a hospital in India between May 2012 and November 2013, as well as healthcare professionals, comprising 25 nurses and 55 resident doctors.	The study used a quasi-experimental design with a prospective interventional study comprising three phases: pretest, intervention, and posttest.	The first phase was to identify nurses' compliance with implementing the VAP bundle. The second phase was to educate nurses and resident doctors through interactive lectures on VAP prevention and the importance of VAP prevention. The third phase was to fill out a checklist of staff compliance in implementing the VAP bundle and its effect on the clinical condition of patients.	There was a decrease in the incidence of VAP, length of stay, duration of mechanical ventilation, and mortality. In addition, nurse compliance with the VAP bundle increased.	Training and the use of checklists in the implementation of the VAP bundle improve the quality of care for patients and increase nurse compliance in implementing the VAP bundle.
2.	The Impact of a Multidisciplinary Education Program for Intensive Care Unit Staff Regarding	This study aims to identify staff compliance in the ICU and the incidence of VAP before and after implementing an educational program related	The sample in this study involved 105 patients on mechanical ventilation who were treated in the ICU and ICU healthcare personnel consisting of	This study used a retrospective and interventional study design in the ICU of a hospital in Turkey from January 2019 to	In this study, ICU staff attended a two-day educational lecture on implementing the VAP bundle. After receiving the educational program, ICU	After the education program was implemented, compliance with the VAP bundle increased significantly, and the frequency of VAP incidents	The educational intervention in this study improved nurses' compliance in implementing the VAP bundle and significantly reduced the

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No.	Title and Author	Purpose	Population/Sample	Method	Intervention	Outcome	Results and Conclusions
	Ventilator Care Bundle on the Frequency of Ventilator-Associated Events (Adiyeke et al., 2021)	to the VAP bundle.	nurses, doctors, and respiratory therapists.	September 2019.	staff underwent an evaluation by completing a multiple-choice examination questionnaire. Nurses' compliance in implementing the VAP bundle was recorded daily using a checklist during multidisciplinary rounds.	decreased. Meanwhile, mortality rates among patients treated in the ICU before and after the VAP bundle education program remained the same.	incidence of VAP in patients on mechanical ventilation in the ICU.
3.	Implementation of an experiential learning strategy to reduce the risk of ventilator-associated pneumonia in critically ill adult patients (Michelángelo et al., 2020)	This study evaluates the impact of implementing experiential learning strategies on staff compliance in the ICU in implementing the VAP bundle and the incidence of VAP events.	The population and sample in this study were all staff in the ICU, including registered nurses, doctors, respiratory therapists, and physiotherapists.	This study used a longitudinal, quasi-experimental, interrupted time-series study method at a tertiary teaching hospital in Buenos Aires, Argentina, from January 2016 to December 2018.	The intervention was conducted in the ICU starting on January 2, 2017, and focused on play activities, simulation models, knowledge and attitude competencies, role-playing, and feedback.	There was a significant difference in nurses' compliance with the VAP bundle before and after the intervention, and there was also a decrease in VAP incidents.	Implementing the experiential learning strategy improved nurses' compliance with the VAP bundle in caring for patients in the ICU.

No.	Title and Author	Purpose	Population/Sample	Method	Intervention	Outcome	Results and Conclusions
4.	Education to prevent ventilator-associated pneumonia in intensive care unit (Branco et al., 2020)	This study aims to evaluate nurses' compliance in implementing the VAP bundle and the incidence of VAP after continuous education.	The sample for this study consisted of 302 patients on mechanical ventilation and 48 nurses working in the ICU.	The research method was a quasi-experimental, pre- and post-intervention, retrospective study with a quantitative approach. The study was conducted at a large hospital in Porto Alegre, Brazil, from June 2017 to June 2018.	The education sessions lasted 20 minutes each. Topics covered in each session included VAP diagnosis, risk factors and prevention strategies, implementation of the VAP bundle, team compliance with preventive measures, and the importance of patient safety in the ICU. The material was discussed using multimedia. The study continued in the second phase by collecting and evaluating nurses' compliance records with implementing the VAP bundle.	After the continuous education program, nurse compliance significantly increased (overall compliance rate of 92.7%). The incidence of VAP also decreased significantly, from 7.99 to approximately 4.28 per 1,000 mechanical ventilator placements after the intervention.	Continuous education on the VAP bundle can improve nurses' compliance with its implementation and reduce the incidence of VAP.
5.	Interprofessional approach	This study aims to improve the	The study involved 80 nurses and 24	The study was conducted using	The intervention involved peer-	With the implementation	The interprofessiona

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No.	Title and Author	Purpose	Population/Sample	Method	Intervention	Outcome	Results and Conclusions
	to the sustained reduction in ventilator-associated pneumonia in a pediatric intensive care unit (McBeth et al., 2018)	implementation of the VAP bundle using an interprofessional approach to reduce the incidence of VAP in pediatric intensive care units.	pediatric beds in the pediatric intensive care unit of a hospital in California. The study also involved prevention specialists and respiratory care therapists.	experimental methodology.	based education through one-on-one teaching (mentoring), brief in-services, posters, quizzes, and bedside teaching. The intervention was implemented over five months. The program continued and was evaluated through compliance audits.	of this program, nurses' compliance with the VAP bundle also increased to over 95% after the intervention was implemented from August 2010 to June 2017.	l approach to implementing the VAP bundle has proven to increase the knowledge and compliance of healthcare workers, including nurses. As a result, the incidence of VAP in the PICU has decreased.
6..	Prevention of Ventilator-Associated Pneumonia: The Multimodal Approach of the Spanish ICU “Pneumonia Zero” Program (Álvarez-Lerma et al., 2018)	The main objective of this study was to assess the impact of the "Pneumonia Zero" project with a multimodal approach in reducing ICU VAP incidence.	This study's sample consisted of 181 patients in the ICU. The patients included were those who had received care for more than 24 hours and were admitted between April 1, 2011, and December 31, 2011. The study also involved healthcare professionals, including nurses.	This study used a prospective, interventional, and multicenter design. The study period lasted 21 months, from April 1, 2011, to December 31, 2012, and the setting was the ICU of a hospital in Spain.	In this study, healthcare professionals, including nurses, received a 6-hour online training course. The course covered clinical aspects of VAP prevention and basic patient safety concepts to help them learn from mistakes and improve teamwork.	There was an increase in nurse compliance and a decrease in VAP incidence from 9.83 events per 1,000 ventilator days (95% CI, 8.42-11.48) to 4.34 (95% CI, 3.22-5.84) after 19-21 months of participation.	Implementing the VAP bundle, part of the "Pneumonia Zero" project, resulted in a significant reduction of over 50% in VAP incidents in the ICU. This reduction persisted for 21 months after implementation .

No.	Title and Author	Purpose	Population/Sample	Method	Intervention	Outcome	Results and Conclusions
7.	Ventilator-associated pneumonia and the importance of education of ICU nurses on prevention - Preliminary results (Mogyoródi et al., 2016)	This study aims to identify the effectiveness of educating nurses in the ICU about implementing the VAP bundle in preventing VAP.	Nurses working in the ICU at Semmelweis University, Budapest, Hungary, along with all patients admitted to the 12-bed multidisciplinary ICU during the study period.	A prospective observational study was conducted in the 12-bed multidisciplinary ICU from January 1, 2015, to December 31, 2015.	Researchers educated all ICU nurses on the importance of implementing the VAP bundle to prevent VAP, which includes head-of-bed elevation, oral care, hand hygiene, cuff pressure control, aseptic endotracheal suctioning technique, and handling of respiratory equipment. This education also included simulation/practice using a "High-Fidelity" practical simulation on endotracheal suctioning and general training.	There was a 44% reduction in VAP incidence, from 21.5 per 1,000 ventilator placements to 12 per 1,000 ventilator placements. Additionally, education on the implementation of the VAP bundle improved ICU nurses' compliance with VAP prevention measures.	It is important to conduct continuous education to prevent VAP.
8.	Sustained Reduction of Ventilator-Associated	This study aims to implement a comprehensive program that	This study's population consisted of patients and nurses	The study design employs a before-and-after quasi-	The dashboard, displayed as a screensaver on each computer	The incidence of VAP decreased from 19.5 to 9.2 per 1,000	The VAP prevention program using a real-time

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No.	Title and Author	Purpose	Population/Sample	Method	Intervention	Outcome	Results and Conclusions
	Pneumonia Rates Using Real-Time Course Correction with a Ventilator Bundle Compliance Dashboard (Talbot et al., 2016)	includes a real-time bundle compliance dashboard to improve nurse compliance and reduce complications related to the use of mechanical ventilation.	from six adult ICUs at Vanderbilt University Hospital (VUH) in Nashville, Tennessee, Southern Kentucky, and Northern Alabama.	experimental study with interrupted time-series analysis. The study was conducted in 6 adult ICUs in Alabama, United States. The study period ran from the baseline period of January 2005 to July 2007, with the implementation /intervention period from August 2007 to June 2011.	next to the ICU patient's bed, integrates data from electronic nursing records, physician order entry systems, and respiratory therapist documentation. The dashboard system receives real-time updates on nurses' performance in preventing VAP and adjusts colour-coded performance indicators every 5 minutes. Each colour code has a specific meaning.	mechanical ventilator placements per day ($p<0.001$). Additionally, the program improved nurse compliance with the VAP bundle in the ICU from a score of 23% in August 2007 to 83% in June 2011 ($p<0.001$).	bundle compliance dashboard is associated with increased nurse compliance and decreased VAP incidence rates in adult ICUs.

IV. DISCUSSION

Various research findings indicate that nurses are not yet optimal in implementing the VAP bundle. Several studies indicate that nurses still lack adequate knowledge and have low compliance rates in implementing the VAP bundle (Al-Sayaghi, 2014; Aziz et al., 2020; Cal, 2015; Ismail & Zahran, 2015; Nurhayati & Priambodo, 2018). Additionally, there are other barriers to implementing the VAP package. This results in suboptimal implementation of the VAP package, as evidenced by the high incidence of VAP compared to the expected standard of 15% per 1,000 ventilator uses (Aziz et al., 2020).

VAP prevention can be achieved by implementing the VAP bundle. However, the main obstacle faced is the lack of compliance by healthcare professionals, including nurses, with the VAP bundle. An education program with training and the use of VAP bundle action checklist observation sheets provided to healthcare professionals, including nurses, has a significant impact on improving compliance with the VAP bundle and ultimately improves the clinical condition of patients (Dipanjali et al., 2021; Mogyoródi et al., 2016; Radhakrishnan et al., 2021).

Research conducted by Radhakrishnan et al. (2021) showed that training and checklists in implementing the VAP bundle were proven effective in improving nurses' compliance and enhancing the quality of care for patients. This study was conducted in three phases. The first phase was the pre-intervention phase, which lasted six months. During this phase, nurses' compliance with the VAP bundle implementation, demographic data, and clinical data related to VAP development were identified. The second phase was the intervention phase. During this phase, nurses and resident doctors were educated through interactive lectures on VAP prevention and the importance of VAP prevention. This activity was followed by one-on-one communication between the lecturer, nursing staff, and resident doctors to ensure that all staff knew the importance of implementing the VAP bundle. In total, nine interactive lectures were held. Each group consisted of 10-15 participants, and each lecture lasted 25-30 minutes per session. Educational posters were also designed to focus on VAP prevention as a reminder. The posters were displayed throughout the wards and hospital areas. Social media was also used for online communication. The intervention phase lasted for 3 months. The third phase, the post-intervention phase, involved completing a checklist of staff compliance in implementing the VAP bundle and its impact on patients' clinical conditions. Each staff member was also given a pocket guide for implementing the VAP bundle. This phase lasted approximately 6 months.

Adiyeke et al. (2021) also conducted a subsequent study on educational interventions to improve VAP bundle implementation to identify staff compliance in the ICU and VAP incidence rates before and after implementing an educational program on VAP bundle implementation. This study involved healthcare workers in the ICU, including nurses, doctors, and respiratory therapists.

In Adiyeké et al.'s (2021) study, ICU staff attended a two-day educational lecture, with material presented by anesthesiologists, ICU consultants, and infectious disease consultants related to the implementation of the VAP bundle, which consists of head elevation, peptic ulcer disease (PUD) prophylaxis, venous thromboembolism (VTE) prophylaxis, the ABCDE bundle, and oral care. After completing the educational program, ICU staff underwent an evaluation by completing an evaluation questionnaire in the form of a multiple-choice examination. The score must be at least 70% correct answers to be deemed qualified to provide care to patients on mechanical ventilation in the ICU. Nurses' compliance with the VAP bundle was recorded daily using a checklist during multidisciplinary rounds. If ICU staff did not achieve the required score, they were required to retake the online education program with the same material as the previous training. The education program was repeated every three months to assess nurses' competence in caring for mechanically ventilated patients. The study results showed that compliance with the VAP bundle was significantly higher in the post-education group compared to the pre-education group. Additionally, the incidence of VAP was significantly lower in the post-education group compared to the pre-education group, decreasing from 2.5/1,000 to 9.8/1,000 mechanical ventilator placements per day.

Next is a study conducted by Branco et al. (2020), which aims to evaluate nurses' compliance with implementing the VAP bundle and the incidence of VAP after continuous education. In June 2017, the implementation of the VAP bundle in patients on mechanical ventilation began to be evaluated. In December 2017, continuous education intervention was conducted on 48 professional nurses in the ICU. Each education session lasted 20 minutes. Topics covered in each session included VAP diagnosis, risk factors and prevention strategies for VAP, implementation of the VAP bundle, team compliance with preventive measures, and the importance of patient safety in the ICU. The material was discussed using multimedia.

Branco et al.'s (2020) study continued in the second phase by collecting and evaluating nurses' compliance records with implementing the VAP bundle from January to June 2018. Then, nurses' compliance and VAP incidents were compared before (June to December 2017) and after (January to June 2018) continuous education. There was a significant increase in nurse compliance (overall compliance rate of 92.7%) after the continuous education program. There was also a significant decrease in VAP incidence, from 7.99 per 1,000 mechanical ventilator placements before the intervention to approximately 4.28 per 1,000 mechanical ventilator placements after the intervention.

A subsequent study on educational interventions in improving VAP bundle implementation was conducted by (Mogyoródi et al., 2016). The researchers educated all ICU nurses on the importance of implementing the VAP bundle to

prevent VAP, which includes head-of-bed elevation, oral care, hand hygiene, cuff pressure control, aseptic endotracheal suctioning technique, and handling of respiratory equipment. There was a 44% reduction in the incidence of VAP, from 21.5 per 1,000 ventilator placements to 12 per 1,000 ventilator placements. Additionally, education on implementing the VAP bundle has improved ICU nurses' compliance with VAP prevention measures.

Lack of knowledge among nurses can be a barrier to their compliance with VAP prevention efforts (Yeganeh et al., 2019). Nurses' knowledge is crucial for implementing guidelines to enhance compliance with VAP prevention protocols (Hawsawi et al., 2017; Jahansefat et al., 2016). Nurses' knowledge and understanding influence their compliance levels; nurses who have received training on implementing the VAP bundle exhibit higher compliance levels than those who have not received prior training (Aloush & Al-Rawajfa, 2020). Improving nurses' knowledge and competence will influence compliance when implementing the VAP bundle. Nurse compliance is one of the behaviours that can prevent VAP; if nurses are compliant, the likelihood of VAP will decrease, thereby reducing the incidence of VAP.

Another intervention to improve the implementation of the VAP bundle was using the experiential learning strategy method. Research related to this was conducted by Michelángelo et al. (2020). This study aimed to evaluate the impact of implementing the experiential learning strategy on staff compliance in the ICU in implementing the VAP bundle and the incidence of VAP events. This intervention was conducted in the ICU, focusing on play activities, simulation models, knowledge and attitude competencies, role-playing, and feedback. The study focused on identifying risk factors and unit-specific barriers that could potentially contribute to the occurrence of VAP. These activities were conducted face-to-face during each nursing shift to ensure that all healthcare workers involved in patient care participated in the study.

According to Michelángelo et al. (2020), the components of experiential learning consist of: first, general actions, which begin with forming a team consisting of nurses, doctors, pharmacists, physiotherapists, and other staff. The team then performs general care, such as bundles for central venous catheters, urinary catheters, VAP prevention, and handwashing procedures. Second, tracers analyze specific risk factors for each patient (e.g., risk of VAP) to evaluate the team's knowledge and actions if such an event occurs. Third, security walks, where the team strives to understand the context of care, equipment use, and interpersonal behaviour. Fourth, hazard identification through structured question-and-answer games with over 200 clinical scenarios. Fifth, video watching, learning from previous mistakes. Videos are compiled by hospital staff based on real cases from the past. Sixth, role-playing and simulation, where simulation scenarios help identify individual and team roles in improving institutional safety

culture. Seventh is safety assessment, and finally, there is feedback and debriefing, where each activity receives constructive feedback to support continuous quality improvement.

The results of Michelángelo et al. (2020) show a significant difference in nurses' compliance with the VAP bundle before and after the intervention. Compliance rates before the intervention were 60.8% (95% CI: 56.9-64.7), and after the intervention, they increased to 85.6% (95% CI: 81.2-90.1). Additionally, the incidence of VAP decreased from 6.11 (95% CI: 5.82-6.40) to 3.55 (95% CI: 2.96-4.14) per 1,000 mechanical ventilator placements.

Implementing the experiential learning strategy improved nurses' adherence to the VAP bundle in caring for patients in the ICU. The implementation of this strategy requires long-term follow-up. This study shows that a new approach combining gamification, debriefing, and simulation techniques forms the experiential learning strategy as a modality centred on the concept of learning by doing, which impacts compliance with actions and the quality of care for patients in the ICU (Michelángelo et al., 2020).

This study aligns with the findings of Batalden and Davidoff (2007), who state that to achieve success in experiential learning strategies, four key aspects must be considered: (1) everyone must be involved in their learning process, (2) learning must occur through experiences in the field where they work, (3) learning must be relevant to those involved, and (4) learning must facilitate preparation for clinical tasks that are constantly changing and challenging. This strategy can help bridge the gap between knowledge and clinical practice.

Experiential learning is a model of teaching and learning that activates learners to build knowledge and skills through their direct experiences (Majid, 2014). Experiential learning is also a process of constructing or compiling knowledge, skills, and values from direct experiences. This method directs nurses to gain more experience through active and personal involvement than if they only read materials or concepts.

The basic principles of experiential learning or the learning procedures in experiential learning consist of four stages: the real experience stage, the observation and reflection stage, the conceptualization stage, and the implementation stage. Practical experiential learning influences nurses' thinking, attitudes, values, perceptions, and behaviour. The experiential learning strategy, as a modality centred on the concept of learning by doing, impacts compliance with the implementation of the VAP bundle, thereby enhancing nurses' behaviour in executing the VAP bundle, which can reduce the incidence of VAP (Michelángelo et al., 2020).

Training on the VAP bundle using experiential learning allows nurses to participate actively in the learning process rather than merely being passive listeners (Solely et al., 2015). The experiential learning strategy is a form of direct

learning which aligns with adult learning that already incorporates concepts and experiences, particularly those related to the VAP bundle. Therefore, the experiential learning strategy will make nurses feel more valued in their knowledge and experience. The experiential learning strategy develops adult learning through experience and then encourages reflection on that experience to develop new skills, attitudes, or ways of thinking. When implemented with the experiential learning strategy, implementing the VAP bundle will be more structured and more focused on carrying out interventions related to preventing VAP.

Several studies have shown that a professional approach can improve the implementation of the VAP bundle. One such study was conducted by McBeth et al. (2018), which aimed to improve the implementation of the VAP bundle using an interprofessional approach to reduce the incidence of VAP in the pediatric intensive care unit (PICU). In this study, the VAP bundle was developed and implemented through an interprofessional team approach comprising nurses, infection prevention specialists, respiratory care therapists, and the medical director of the PICU.

Interventions were conducted through peer-based education, including one-on-one teaching (mentoring), brief in-services, posters, quizzes, and bedside teaching. These interventions were carried out over five months. The program continues to be implemented and evaluated through compliance audits. Additionally, nurses from the VAP Prevention Committee immediately provide new nurses joining the unit with VAP bundle training. Education is conducted through online modules and literature reviews related to VAP bundle updates.

In this program, nurses are also given rewards/compensation for their achievements in implementing the VAP bundle, decreasing VAP incidence. The incidence of VAP has decreased year by year. With the implementation of this program, nurse compliance with the VAP bundle has also increased to over 95% after the intervention was implemented from August 2010 to June 2017. The interprofessional approach to implementing the VAP bundle has been proven to increase compliance among healthcare workers, including nurses. As a result, the incidence of VAP in the PICU has continued to decrease.

Another related study is the research by Álvarez-Lerma et al. (2018) which aimed to assess the impact of the "Pneumonia Zero" project with a multimodal approach in reducing VAP incidence in the ICU. This study took measurements of nurses' compliance in implementing the VAP bundle and its effect on reducing VAP incidence. In this study, healthcare professionals, including nurses, received a 6-hour online training course. The course covered clinical aspects of VAP prevention and basic patient safety concepts to learn from mistakes and improve teamwork.

The components of the VAP bundle in this study (Álvarez-Lerma et al., 2018) included education and training in airway management; hand hygiene; control and maintenance of ETT cuff pressure; oral hygiene with chlorhexidine; semi-

recumbent position; safe implementation of procedures and protocols; avoiding elective changes to ventilator circuits and humidifiers; selective gastrointestinal decontamination or selective oropharyngeal decontamination; continuous subglottic secretion aspiration; and short-term systemic antibiotic administration (2-3 doses) during intubation in patients with impaired consciousness. The incidence of VAP decreased from 9.83 events per 1,000 ventilator days (95% CI, 8.42-11.48) to 4.34 (95% CI, 3.22-5.84) after 19-21 months of participation. Implementing the VAP bundle, part of the "Pneumonia Zero" project, resulted in a significant reduction of over 50% in VAP incidents in the ICU. This reduction persisted for 21 months after implementation.

Research findings indicate that strong nursing leadership, interprofessional teamwork, and commitment to long-term success are crucial for maintaining adherence to the VAP bundle implementation (Costa et al., 2016; Hill, 2016). Leadership is closely related to an individual's ability to influence others to work toward desired goals. With a coordinated interprofessional approach, implementing the VAP bundle can reduce VAP incidence in the ICU. Effective coordination and leadership are essential for successfully implementing the VAP bundle, and nurses play a crucial role.

Another intervention to improve the implementation of the VAP bundle among ICU nurses is using a real-time bundle compliance dashboard. In this regard, Talbot et al. (2016) conducted a study to implement a comprehensive program that includes a real-time bundle compliance dashboard to improve nurse compliance and reduce complications resulting from mechanical ventilation. The dashboard, displayed as a screensaver on every computer next to the ICU patient bed, integrates data from electronic nursing records, the physician order entry system, and respiratory therapist documentation. The dashboard system receives real-time updates on nurses' performance in preventing VAP and adjusts the colour-coded performance indicators every five minutes. Each colour code has a specific meaning. The dashboard is designed to remind nurses when the VAP bundle is being implemented through a colour-coded visual display (green: bundle components have been completed and are compliant; yellow: bundle components are compliant, but there is an upcoming deadline to repeat the intervention; red: bundle components have not been completed and are overdue).

The VAP bundle in Talbot et al.'s (2016) study includes prophylaxis for DVT and pressure ulcers, sedation management and assessment of extubation readiness, HoB elevation, and oral care. The incidence of VAP decreased from 19.5 to 9.2 per 1,000 mechanical ventilator placements per day ($p < 0.001$). Additionally, this program improved nurse compliance with the VAP bundle in the ICU from a score of 23% in August 2007 to 83% in June 2011 ($p < 0.001$). Compliance with the VAP bundle was evaluated twice daily during interdisciplinary rounds in the morning and evening. These changes were sustained for over three years.

Another study conducted by Fathi et al. (2018) showed that real-time dashboards can be implemented with real-time data display and visual features that help nurses understand the current condition of patients. Thus, they can take the necessary actions. Additionally, alerts and reminders are one of the practical features of this software. With order lists and instructions on performing actions, the real-time dashboard can minimize human errors related to the time taken and the action method. The real-time dashboard also represents the history of actions already performed, preventing errors caused by coordination issues among healthcare professionals on duty.

The results of this study are also in line with research conducted by Zaydfudim et al. (2009), which showed that nurses' compliance in implementing the VAP bundle increased from 39% to 89%, while the incidence of VAP decreased from 15.2 to 9.3 cases per 1,000 mechanical ventilator uses per day after the implementation of the real-time dashboard. Based on research conducted by Talbot et al. (2016) and Zaydfudim et al. (2009), a VAP prevention program using a real-time bundle compliance dashboard is associated with increased nurse compliance and decreased VAP incidence rates in the ICU. This occurs because the real-time bundle compliance dashboard allows nurses to evaluate their actions related to the VAP bundle to determine whether they align with the applicable standard operating procedures (SOPs).

With these various interventions, it is hoped that nurses will be compliant in implementing the VAP bundle in patients on mechanical ventilation in the ICU. Implementing the VAP bundle also requires good teamwork and institutional support so that nurses can perform their roles optimally (Akdogan et al., 2017; Doshier et al., 2014).

Clinical Implications

The findings of this scoping review provide important implications for nursing practice, ICU management, and patient safety initiatives. The identified interventions—namely structured education and training programs, experiential learning strategies, interprofessional collaboration, and real-time compliance monitoring dashboards—demonstrate strong potential to improve nurse adherence to VAP bundle implementation. In clinical practice, these strategies can enhance nurses' knowledge, clinical skills, and situational awareness, thereby reducing variability in care and minimizing preventable ventilator-associated pneumonia events.

Healthcare institutions should prioritize continuous, competency-based education supported by regular supervision and audit mechanisms to sustain compliance. Integrating experiential learning and simulation into routine training may further strengthen nurses' critical thinking and clinical decision-making. Additionally, the use of real-time electronic dashboards can support timely

feedback, promote accountability, and facilitate multidisciplinary communication. Implementing these strategies as part of a comprehensive infection prevention program may contribute to improved patient outcomes, reduced ICU length of stay, and lower healthcare costs associated with VAP.

Study Limitations

Several limitations of this scoping review should be considered. First, the included studies exhibited considerable heterogeneity in study design, intervention duration, outcome measures, and ICU settings, which limited direct comparison and synthesis of findings. Second, the review was restricted to articles published in English between 2016 and 2021, potentially excluding relevant studies published outside this timeframe or in other languages. Third, most included studies focused on short- to medium-term outcomes, providing limited evidence on the long-term sustainability of nurse compliance and reductions in VAP incidence. Finally, as a scoping review, this study did not aim to assess intervention effectiveness quantitatively. Future research employing longitudinal designs and standardized outcome measures is recommended to strengthen evidence on sustainable VAP prevention strategies.

V. CONCLUSION

Various interventions can be implemented to improve nurses' compliance with the VAP bundle in the ICU. Based on the scoping review, it was found that to improve nurses' compliance, the following interventions can be implemented: educational and training programs, experiential learning strategies, interprofessional approaches, and real-time bundle compliance dashboards. Educational and training programs ensure that nurses have up-to-date knowledge and skills for implementing the VAP bundle. Meanwhile, experiential learning strategies can provide hands-on experience applying the VAP bundle, enhancing nurses' understanding and skills. Additionally, interprofessional approaches can involve cross-professional collaboration to improve communication and coordination when implementing the VAP bundle. The use of real-time bundle compliance dashboards can provide nurses with immediate feedback on their compliance levels and facilitate ongoing monitoring and improvement of compliance. Therefore, based on the results of this scoping review, it is recommended that nursing care institutions actively implement these strategies to improve nurses' compliance with the VAP bundle. In addition, the nursing education curriculum should also include materials related to VAP prevention using the VAP bundle. With the comprehensive implementation of these interventions, it is hoped that patient care quality will improve and ICU VAP incidents will be prevented.

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Author Contributions

All authors contributed substantially to the conception and design of the study. The literature search, study selection, data extraction, and synthesis were conducted collaboratively. All authors contributed to manuscript drafting and critical revision, approved the final version of the manuscript, and agree to be accountable for all aspects of the work.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Data Availability Statement

All data supporting the findings of this scoping review are derived from publicly available published literature. Detailed information on included studies is presented within the article and its supplementary materials.

VI. REFERENCES

- Adiyeke, E., Koc, B. I., Coskun, N., Bakan, N., Sen, E., Turan, A., & Ozturk, H. (2021). The Impact of a Multidisciplinary Education Program for Intensive Care Unit Staff Regarding Ventilator Care Bundle on the Frequency of Ventilator-Associated Events. *Dimensions of Critical Care Nursing*, 40(4), 210-216. <https://doi.org/10.1097/DCC.0000000000000484>
- Akdogan, O., Ersoy, Y., Kuzucu, C., Gedik, E., Togal, T., & Yetkin, F. (2017). Assessment of the effectiveness of a ventilator associated pneumonia prevention bundle that contains endotracheal tube with subglottic drainage and cuff pressure monitorization. *Brazilian Journal of Infectious Diseases*, 21(3), 276-281. <https://doi.org/10.1016/j.bjid.2017.01.002>
- Al-Sayaghi, K. (2014). Prevention of ventilator associated pneumonia: a knowledge survey among intensive care nurse in Yemen. *Saudi Med J.*, 35(3), 269-275.
- Aloush, S. M. (2017). Does educating nurses with ventilator-associated pneumonia prevention guidelines improve their compliance? *Am J Infect Control*, 45(9), 969-973. <https://doi.org/10.1016/j.ajic.2017.04.009>



- Aloush, S. M., & Al-Rawajfa, O. M. (2020). Prevention of ventilator-associated pneumonia in intensive care units: Barriers and compliance. *International Journal of Nursing Practice*, 26(5), e12838. <https://doi.org/https://doi.org/10.1111/ijn.12838>
- Álvarez-Lerma, F., Palomar-Martínez, M., Sánchez-García, M., Martínez-Alonso, M., Álvarez-Rodríguez, J., Lorente, L., Arias-Rivera, S., García, R., Gordo, F., Añón, J. M., Jam-Gatell, R., Vázquez-Calatayud, M., & Agra, Y. (2018). Prevention of ventilator-Associated pneumonia: The multimodal approach of the Spanish ICU “pneumonia zero” program. *Critical Care Medicine*, 46(2), 181-188. <https://doi.org/10.1097/CCM.0000000000002736>
- Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *Int J Soc Res Methodol*, 8(1), 19-32. <https://doi.org/10.1080/1364557032000119616>
- Azab, S. F. A., Sherbiny, H. S., Saleh, S. H., Elsaed, W. F., Elshafiey, M. M., Siam, A. G., Arafa, M. A., Alghobashy, A. A., Bendary, E. A., Basset, M. A. A., Ismail, S. M., Akeel, N. E., Elsamad, N. A., mokhtar, W. A., & Gheith, T. (2015). Reducing ventilator-associated pneumonia in neonatal intensive care unit using “VAP prevention Bundle”: A cohort study. *BMC Infectious Diseases*, 15(1), 4-10. <https://doi.org/10.1186/s12879-015-1062-1>
- Aziz, Z., Kausar, S., Zahid, S., Farooqi, S., Aziz, Z., & Ahmad, R. A. (2020). Knowledge and practice of ventilator care bundle for preventing ventilator associated pneumonia by ICU nurses of tertiary care hospitals of Lahore. *Anaesthesia, Pain and Intensive Care*, 24(4), 426-434. <https://doi.org/10.35975/apic.v24i4.1315>
- Batalden, P. B., & Davidoff, F. (2007). What is “quality improvement” and how can it transform healthcare? *Quality and Safety in Health Care*, 16(1), 2-3. <https://doi.org/10.1136/qshc.2006.022046>
- Branco, A., Lourençone, E. M. S., Monteiro, A. B., Fonseca, J. P., Blatt, C. R., & Caregnato, R. C. A. (2020). Education to prevent ventilator-associated pneumonia in intensive care unit. *Revista Brasileira de Enfermagem*, 73(6), e20190477. <https://doi.org/10.1590/0034-7167-2019-0477>
- Budiono, P. (2013). Hubungan Antara Lama Penggunaan Ventilator Mekanik Dengan Kejadian Ventilator Associated Pneumonia (VAP) Pada Pasien Nonsepsis di ICU RSUP Dr. Kariadi Semarang. *Jurnal UNDIP*.
- Cal, P. (2015). *Ventilator-Associated Pneumonia Prevention Bundle*.
- Center for Disease Control and Prevention (CDC). (2021). *Pneumonia (Ventilator-associated [VAP] and nonventilator-associated Pneumonia [PNEU]) Event*.

- Cooper, V. B., & Haut, C. (2013). Preventing Ventilator-Associated Pneumonia in Children: An Evidence-Based Protocol. *Critical Care Nurse*, 33(3), 21-29. <https://doi.org/https://doi.org/10.4037/ccn2013204>
- Costa, D. K., Yang, J. J., & Manojlovich, M. (2016). The critical care nurse work environment, physician staffing, and risk for ventilator-associated pneumonia. *Am J Infect Control*, 44(10), 1181-1183. <https://doi.org/10.1016/j.ajic.2016.03.028>
- Damayanti, M., & Handiyani, H. (2021). Low compliance, limited facilities, and insufficient budget funds become obstacles in the implementation of infection and prevention control programs: A phenomenology study. *Enfermería Clínica*, 31(2), S45-S49. <https://doi.org/https://doi.org/10.1016/j.enfcli.2020.10.016>
- Dipanjali, R., Shivananda, P. M., & Yashoda, S. (2021). Effectiveness of an Educational Intervention on Knowledge and Practice of Staff Nurses on Prevention of Ventilator Associated Pneumonia (VAP) Among Neonates in NICU. *International Journal of Caring Sciences*, 14(1), 8-17. http://internationaljournalofcaringsciences.org/docs/2_mamantha_origina_14_1.pdf
- Dosher, W. B., Loomis, E. C., Richardson, S. L., Crowell, J. A., Waltman, R. D., Miller, L. D., Nazim, M., & Khasawneh, F. A. (2014). The effect of a nurse-led multidisciplinary team on ventilator-associated pneumonia rates. *Critical Care Research and Practice*, 2014. <https://doi.org/10.1155/2014/682621>
- Fathi, M., Moghaddasi, H., Hosseini, A., & Aghdam, M. E. (2018). Developing a Dashboard Software for the ICUs and Studying its Impact on Reducing the Ventilator-Associated Pneumonia. *The Open Medical Informatics Journal*, 12(1), 42-50. <https://doi.org/10.2174/1874431101812010042>
- Ferreira, C. R., de Souza, D. F., Cunha, T. M., Tavares, M., Reis, S. S. A., Pedroso, R. S., & Röder, D. V. D. de B. (2016). The effectiveness of a bundle in the prevention of ventilator-associated pneumonia. *Brazilian Journal of Infectious Diseases*, 20(3), 267-271. <https://doi.org/10.1016/j.bjid.2016.03.004>
- Hawsawi, T. H., Al-Naghshabandi, E., & Sofar, S. M. (2017). Effectiveness of Electronic Learning Module in Implementing VentilatorAssociated Pneumonia Prevention Measures of Intensive Care Unit Nurses. *Journal of Advance in Health and Medical Sciences*, 3(3), 126-149. <https://doi.org/10.33425/2639-9474.1062>

- Hill, C. (2016). Nurse-led implementation of a ventilator-associated pneumonia care bundle in a children's critical care unit. *Nurs Child Young People*, 28(4), 23-27. <https://doi.org/10.7748/ncyp.28.4.23.s21>
- Ismail, R., & Zahran, E. (2015). The effect of nurses training on ventilator-associated pneumonia (VAP) prevention bundle on VAP incidence rate at a critical care unit. *Journal OfNursing Education and Practice*, 5(12), 42-48. <https://doi.org/10.5430/jnep.v5n12p42>
- Jahansefat, L., Mehdi Molavi Vardanjani, Bigdelian, H., Massoumi, G., Khalili, A., & Mardani, D. (2016). Exploration of knowledge of, adherence to, attitude and barriers toward evidence-based guidelines (EBGs) for prevention of ventilator-associated pneumonia (VAP) in healthcare workers of pediatric cardiac intensive care units (PICUs): A Quali-Quantitative. *International Journal of Medical Research and Health Sciences*, 5(9), 67-73.
- Joint Commission on the Accreditation of Healthcare Organizations. (2005). *Candidate Core Measure Set*.
- Madhuvu, A., Endacott, R., Plummer, V., & Morphet, J. (2020). Nurses' knowledge, experience and self-reported adherence to evidence-based guidelines for prevention of ventilator-associated events: A national online survey. *Intensive and Critical Care Nursing*, 59. <https://doi.org/https://doi.org/10.1016/j.iccn.2020.102827>
- Majid, A. (2014). *Belajar dan pembelajaran*. PT Rosdakarya.
- McBeth, C. L., Montes, R. S., Powne, A., North, S. E., & Natale, J. A. E. (2018). Interprofessional approach to the sustained reduction in ventilator-associated pneumonia in a pediatric intensive care unit. *Critical Care Nurse*, 38(6), 36-46. <https://doi.org/10.4037/ccn2018121>
- Michelángelo, H., Angriman, F., Pizarro, R., Bauque, S., Kecskes, C., Staneloni, I., García, D., Espínola, F., Mazer, G., & Ferrari, C. (2020). Implementation of an experiential learning strategy to reduce the risk of ventilator-associated pneumonia in critically ill adult patients. *Journal of the Intensive Care Society*, 21(4), 320-326. <https://doi.org/10.1177/1751143719887285>
- Ministry of Health of the Republic of Indonesia. (2017). *Regulation of the Minister of Health of the Republic of Indonesia Number 27 of 2017 concerning Guidelines for Prevention and Control of Infections in Health Care Facilities*.
- Mogyoródi, B., Dunai, E., Gál, J., & Iványi, Z. (2016). Ventilator-associated pneumonia and the importance of education of ICU nurses on prevention -

- Preliminary results. *Interventional Medicine and Applied Science*, 8(4), 147-151. <https://doi.org/10.1556/1646.8.2016.4.9>
- Morris, A. C., Hay, A. W., Swann, D. G., Everingham, K., McCulloch, C., McNulty, J., Brooks, O., Laurenson, I. F., Cook, B., & Walsh, T. S. (2011). Reducing ventilator-associated pneumonia in intensive care: impact of implementing a care bundle. *Crit Care Med*, 39(10), 2218-2224. <https://doi.org/10.1097/CCM.0b013e3182227d52>
- Noorifard, M., Farahani, R. H., & Hazrati, E. (2020). The incidence and risk factors of ventilator-associated pneumonia in ICU. *Acta Medica Iranica*, 58(9), 439-444. <https://doi.org/10.18502/acta.v58i9.4765>
- Nurhayati, N., & Priambodo, A. P. (2018). Hubungan pengetahuan dengan pelaksanaan bundle VAP di Ruang Intensif. *Jurnal Kesehatan Aeromedika*, 4(1), 35-39.
- Osman, S., Al, Y. M., Aldabbagh, M., Baksh, M., Osman, M., & Azzam, M. (2020). Journal of Infection and Public Health The incidence of ventilator-associated pneumonia (VAP) in a tertiary-care center : Comparison between pre- and post-VAP prevention bundle. *Journal of Infection and Public Health*, 13(4), 552-557. <https://doi.org/10.1016/j.jiph.2019.09.015>
- Osti, C., Wosti, D., Pandey, B., & Zhao, Q. (2017). Ventilator-associated pneumonia and role of nurses in its prevention. *Journal of the Nepal Medical Association*, 56(208), 461-468. <https://doi.org/10.31729/jnma.3270>
- Peters, M. D. J., Godfrey, C., McInerney, P., Munn, Z., Tricco, A. C., & Khalil, H. (2020). Scoping Reviews. In E. Aromataris & Z. Munn (Eds.), *JBIManual for Evidence Synthesis*, JBI, 2020.
- Radhakrishnan, R., Sood, R., Wig, N., Sethi, P., Soneja, M., Kumar, A., Nischal, N., Ashutosh Biswas, & RM, P. (2021). Effect of Training and Checklist Based Use of Ventilator Associated Pneumonia (VAP) Prevention Bundle Protocol on Patient Outcome: A Tertiary Care Centre Study. *Journal of The Association of Physicians of India*, 68(August), 42-46. <https://doi.org/10.1111/ijlh.13309>
- Rahmawati. (2014). Angka Kejadian Pneumonia Pada Pasien Sepsis di ICU RSUP Dr. Kariadi Semarang. *Jurnal Medika Muda UNDIP Semarang*, 3(1).
- Sadli, M. F., Tavianto, D., & Redjeki, I. S. (2017). Gambaran Pengetahuan Klinisi Ruang Rawat Intensif mengenai Ventilator Associated Pneumonia (VAP) Bundle di Ruang Rawat Intensif RSUP Dr. Hasan Sadikin Bandung. *Jurnal Anestesi Perioperatif*, 5(2), 85. <https://doi.org/10.15851/jap.v5n2.1108>

- Safdar, N., Musuuza, J. S., Xie, A., Hundt, A. S., Hall, M., Wood, K., & Carayon, P. (2016). Management of ventilator-associated pneumonia in intensive care units: A mixed methods study assessing barriers and facilitators to guideline adherence. *BMC Infectious Diseases*, 16(1), 1-10. <https://doi.org/10.1186/s12879-016-1665-1>
- Samra, S. R., Sherif, D. M., & Elokda, S. A. (2017). Impact of VAP bundle adherence among ventilated critically ill patients and its effectiveness in adult ICU. *Egyptian Journal of Chest Diseases and Tuberculosis*, 66(1), 81-86. <https://doi.org/10.1016/j.ejcdt.2016.08.010>
- Silva, C. Da, & Junior, M. (2015). strategies for appropriate antibiotic use in intensive care unit. *Einstein*, 13(3).
- Solely, G., Handiyani, H., & Nuraini, T. (2015). Peningkatan Pengetahuan dan Kepatuhan Melakukan Kebersihan Tangan melalui Pelatihan dengan Fluorescence Lotion. *Jurnal Keperawatan Indonesia*, 18(2), 123-131.
- Speck, K., Rawat, N., Weiner, N. C., Tujuba, H. G., Farley, D., & Berenholtz, S. (2016). A Systematic Approach for Developing a Ventilator-Associated Pneumonia Prevention Bundle. *Am J Infect Control.*, 44(6), 652-656. <https://doi.org/10.1016/j.ajic.2015.12.020>
- Talbot, T. R., Carr, D., Lee Parmley, C., Martin, B. J., Gray, B., Ambrose, A., & Starmer, J. (2016). Sustained reduction of ventilator-associated pneumonia rates using Real-Time course correction with a ventilator bundle compliance dashboard. *Infection Control and Hospital Epidemiology*, 36(11), 1261-1267. <https://doi.org/10.1017/ice.2015.180>
- Tricco, A. C., Lillie, E., & Zarin, W. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*, 169(7), 467-473. <https://doi.org/10.7326/M18-0850>
- Yeganeh, M., Yekta, H., Farmanbar, R., Khalili, M., Khaleghdoost, T., & Roushan, Z. A. (2019). Knowledge of evidence-based guidelines in ventilator-associated pneumonia prevention. *Journal of Evidence Based Medicine*, 12(1), 16-21. <https://doi.org/0.1111/jebm.12188>
- Zaiton, H. I., & Elhanafy, E. Y. (2015). Impact of Implementation Nursing Guidelines on Minimizing Ventilator Associated Pneumonia among Intensive Care PatientsNo Title. *Advances in Life Science and Technology*, 29(ISSN 2224-7181), 40-51.
- Zaragoza, R., Vidal-cortés, P., Aguilar, G., Borges, M., Diaz, E., Ferrer, R., Maseda, E., Nieto, M., Nuvials, F. X., Ramirez, P., & Rodriguez, A. (2020). *Update of the treatment of nosocomial pneumonia in the ICU*. 1-13.

Zaydfudim, V., Dossett, L. A., Starmer, J. M., Arbogast, P. G., Feurer, I. D., Ray, W. A., May, A. K., & Pinson, C. W. (2009). Implementation of a real-time compliance dashboard to help reduce SICU ventilator-associated pneumonia with the ventilator bundle. *Archives of Surgery*, 144(7), 656-661. <https://doi.org/10.1001/archsurg.2009.117>

