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Factors influencing nurses' adherence to ventilator-associated pneumonia prevention bundles: a scoping review

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ABSTRACT

Introduction: Ventilator-associated pneumonia is a healthcare-associated infection with a significant impact on morbidity, mortality, length of stay, and hospital costs in intensive care units. Nurses' adherence to prevention bundles plays a key role in the effectiveness of these interventions, although it is influenced by multiple factors.
Objective: To map the available scientific evidence on the factors influencing nurses' adherence to ventilator-associated pneumonia prevention bundles in intensive care units.
Methodology: Scoping review conducted in accordance with the Joanna Briggs Institute methodology and PRISMA-ScR. Eligibility criteria were defined according to the PCC framework (Participants – nurses providing care to patients undergoing mechanical ventilation in the ICU; Concept – studies addressing nurses' adherence or non-adherence to ventilator-associated pneumonia prevention bundles, as well as factors associated with their implementation; Context – studies conducted in intensive care units or equivalent hospital settings providing care to critically ill patients receiving invasive mechanical ventilation). Studies published in Portuguese, English, and Spanish were included, identified through the MEDLINE Complete (via PubMed), CINAHL Complete, MedicLatina, and Cochrane Central Register of Controlled Trials (via EBSCOhost) databases, and selected by two independent reviewers, with a third reviewer involved in cases of disagreement. The search was conducted in March 2026.
Results: Five core categories were identified: team training and capacity building; implementation strategies and practice monitoring; institutional resources and organizational conditions; professional and organizational factors; and clinical outcomes and care indicators. Continuous training, audit and feedback, practice monitoring, availability of resources, and institutional support were found to promote adherence, whereas workload, staff turnover, communication failures, and resource shortages may hinder it.
Conclusion: Nurses' adherence to ventilator-associated pneumonia prevention bundles is influenced by multiple and interdependent factors, reinforcing the importance of integrated strategies involving training, monitoring, and organizational support to promote safe, evidence-based practice.

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INFORMAÇÃO DO ARTIGO

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Palavras-chave:
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RESUMO

Introdução: A pneumonia associada à ventilação mecânica constitui uma infeção associada aos cuidados de saúde com impacto relevante na morbilidade, mortalidade, duração do internamento e custos hospitalares em unidades de cuidados intensivos. A adesão dos enfermeiros aos pacotes de prevenção assume um papel determinante na eficácia destas intervenções, embora seja influenciada por múltiplos fatores.
Objetivo: Mapear a evidência científica disponível sobre os fatores que influenciam a adesão dos enfermeiros aos pacotes de prevenção da pneumonia associada à ventilação mecânica em unidades de cuidados intensivos.
Metodologia: Revisão de escopo conduzida de acordo com o modelo do *Joanna Briggs Institute* e PRISMA-ScR. Os critérios de elegibilidade foram definidos pelo PCC (Participantes – enfermeiros que prestam cuidados a doentes sob ventilação mecânica em UCI; Conceito – estudos que abordassem a adesão ou não adesão dos enfermeiros aos pacotes de prevenção da PAVM, bem como os fatores associados à sua implementação; Contexto – estudos desenvolvidos em unidades de cuidados intensivos ou em contextos hospitalares equivalentes de prestação de cuidados à pessoa em situação crítica sob ventilação mecânica invasiva.). Foram incluídos estudos publicados em português, inglês e espanhol, identificados nas bases de dados MEDLINE® Complete (via PubMed), CINAHL® Complete, MedicLatina® e Cochrane Central Register of Controlled Trials® (via EBSCOhost®) selecionados por dois revisores independentes, com um terceiro revisor em caso de desacordo. Pesquisa realizada em Março de 2026.
Resultados: Identificadas cinco categorias centrais: formação e capacitação da equipa; estratégias de implementação e monitorização das práticas; recursos institucionais e condições organizacionais; fatores profissionais e organizacionais; e resultados clínicos e indicadores assistenciais. A formação contínua, a auditoria com feedback, a monitorização das práticas, a disponibilidade de recursos e o suporte institucional favorecem a adesão, enquanto a carga de trabalho, a rotatividade profissional, as falhas de comunicação e a escassez de recursos podem dificultá-la.
Conclusão: A adesão dos enfermeiros aos pacotes de prevenção da pneumonia associada à ventilação mecânica é influenciada por fatores múltiplos e interdependentes, reforçando a importância de estratégias integradas de formação, monitorização e suporte organizacional para promover práticas seguras e baseadas na evidência.

Introduction

Ventilator-associated pneumonia (VAP) is a serious healthcare-associated infection that primarily affects critically ill patients receiving invasive mechanical ventilation in intensive care units (ICUs).[1] It is generally defined as pneumonia developing after at least 48 hours of invasive mechanical ventilation and remains associated with increased morbidity, mortality, duration of mechanical ventilation, length of stay, and healthcare costs.[1-3] Recent evidence continues to show that VAP represents an important burden for critically ill patients and healthcare systems, reinforcing the need for effective preventive strategies.[2,3] In this context, VAP prevention bundles have become one of the most widely used approaches to support safer and more consistent care for mechanically ventilated patients.[2,4,5] These bundles are generally understood as a set of evidence-based interventions that, when implemented together and with high reliability, may contribute to reducing the incidence of VAP and improving care processes.[1,4] Recent synthesis studies support the use of bundled approaches, showing that their implementation is associated with a reduction in VAP episodes and, in some studies, with shorter duration of mechanical ventilation and hospital stay.[4,5] However, it is important to acknowledge that there is no universally agreed single composition of a VAP prevention bundle.[2,4-6] International guidance and synthesis studies describe recurrent components, but also considerable variability across studies, institutions, and healthcare systems.[2,5,7] The 2022 update developed by the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), and the Association for Professionals in Infection Control and Epidemiology (APIC) for acute-care

hospitals identifies essential practices for adult patients such as minimizing sedation whenever possible, maintaining and improving physical conditioning, elevating the head of the bed to 30°–45°, providing oral care with toothbrushing without chlorhexidine, and appropriately managing ventilator circuits.[2] The same guidance presents endotracheal tubes with subglottic secretion drainage as an additional approach for selected patients, particularly when prolonged ventilation is expected. This variability is also reflected in the research literature.[4,5] A systematic review and meta-analysis published in 2023, which included 36 studies and 116,873 mechanically ventilated adult patients, found that the most frequently reported bundle components were head-of-bed elevation and oral care, while the overall composition of bundles differed across studies.4 Importantly, despite this heterogeneity, the implementation of care bundles was associated with a significant reduction in VAP episodes, supporting their clinical relevance while also highlighting the lack of a universally standardized bundle.[4,5] A second recent systematic review focusing on adult ICUs likewise concluded that bundle composition varied substantially, ranging from four to thirteen interventions across studies.[5] Some bundle elements also remain the subject of ongoing discussion.[2,8] One important example concerns oral chlorhexidine.[2,8] The 2022 SHEA/IDSA/APIC recommendations do not support routine oral care with chlorhexidine for VAP prevention and instead favor oral care with toothbrushing without chlorhexidine.[2] This position is consistent with more recent synthesis evidence showing that chlorhexidine has not demonstrated clear benefit across clinically relevant outcomes in critically ill ventilated patients.[8] These findings reinforce the need to interpret bundle components in light of updated evidence rather than assuming that all historically used elements remain equally supported.[2,8] More recent international guidance has also emphasized that preventive recommendations should be interpreted according to local organizational conditions, available resources, and care settings, including resource-limited environments.[3] This issue is particularly relevant when considering nurses' adherence, because the effective implementation of bundle measures depends not only on individual knowledge and motivation, but also on the clarity of bundle components, institutional leadership, staff education, availability of material resources, and the feasibility of integrating these interventions into routine practice.[2,3] The literature further suggests that nurses' knowledge and training are central to adherence.[9-12] Educational interventions and structured training programs have been associated with improved compliance with VAP preventive measures, whereas gaps in knowledge, insufficient formal training, workload, communication failures, and lack of resources may compromise implementation.[9-11] At the same time, monitoring strategies such as audits, feedback, supervision, and protocol-based practice appear to facilitate more consistent adherence to preventive measures in ICU settings.[9,11] Given the clinical relevance of VAP, the central role of nurses in implementing preventive measures, and the conceptual and operational heterogeneity surrounding VAP prevention bundles, it is important to better understand the factors influencing nurses' adherence to these interventions.[2,4] Mapping the available evidence on this topic may help guide quality improvement strategies, support clinical and organizational decision-making, and strengthen patient safety in intensive care settings.[3,4,11,13]

Methodology

Study design

This scoping review was conducted in accordance with the methodology proposed by the Joanna Briggs Institute (JBI)[14] for scoping reviews and reported in line with the PRISMA-ScR guidelines.[15] A scoping review was considered the most appropriate methodological approach because the aim of this study was to map the breadth and nature of the available evidence on the factors influencing nurses' adherence to ventilator-associated pneumonia prevention bundles in intensive care settings.

Objective and review question

The objective of this review was to map the available scientific evidence on the factors influencing nurses' adherence to ventilator-associated pneumonia prevention bundles in intensive care units. The review question was: *What factors influence nurses' adherence to ventilator-associated pneumonia prevention bundles in intensive care units?* The research question defined for this review was: What factors influence nurses' adherence to ventilator-associated pneumonia prevention bundles in intensive care units?

Protocol and registration

The review was registered on the Open Science Framework (OSF) under the code https://osf.io/9pqn5/.

Eligibility criteria

Eligibility criteria were defined according to the PCC framework (Participants, Concept, and Context). Participants included nurses providing care to adult patients receiving invasive mechanical ventilation in intensive care units. The concept comprised studies addressing nurses' adherence or non-adherence to ventilator-associated pneumonia prevention bundles, as well as factors associated with their implementation. The context included adult intensive care units or equivalent hospital settings providing care to critically ill adult patients receiving invasive mechanical ventilation.

Studies focusing exclusively on pediatric or neonatal populations, studies conducted outside hospital or intensive care settings, and studies that did not address nurses' adherence to VAP prevention bundles or related influencing factors were excluded. Studies published in Portuguese, English, and Spanish were included. Original studies and literature reviews were considered eligible when they addressed factors associated with nurses' adherence to VAP prevention bundles in intensive care settings. Reviews and institutional documents used exclusively for conceptual framing were not included in the final sample.

Search strategy

The search strategy was conducted in three stages. In the initial stage, a broad search was carried out in the MEDLINE® Complete (via PubMed); CINAHL® Complete, MedicLatina® and Cochrane Central Register of Con-trolled Trials® (via EBSCOhost®) databases in order to analyze the keywords of interest contained in the titles and abstracts and the in-dexing terms of the studies. In a second stage, a broader search was carried out in the search engines using the Boolean operators AND and OR, with AND used to identify studies and OR used for synonyms, according to the combinations between descriptors. The search strategy was adapted to the syntax and indexing specificities of each database, while maintaining the same central concepts defined according to the PCC acronym. Table 1 presents the search expressions used and the number of studies identified in each database consulted.

Table 1. Search strategy applied in the databases.

Database	Search strategy	Results
MEDLINE®	("critical care nursing" OR nursing OR nurse* OR "intensive care nursing") AND ("care bundle*" OR bundle* OR "patient care bundle*" OR "ventilator bundle*") AND ("ventilator-associated pneumonia" OR "ventilator associated pneumonia" OR VAP OR PAVM) AND ("disease prevention" OR prevention OR "infection prevention") AND ("guideline adherence" OR adherence OR compliance OR "fidelity to guidelines")	41
CINAHL®	("critical care nursing" OR nursing OR nurse* OR "intensive care nursing") AND ("care bundle*" OR bundle* OR "patient care bundle*" OR "ventilator bundle*") AND ("ventilator-associated pneumonia" OR "ventilator associated pneumonia" OR VAP OR PAVM) AND ("disease prevention" OR prevention OR "infection prevention") AND ("guideline adherence" OR adherence OR compliance OR "fidelity to guidelines")	27
Cochrane Central Register of Controlled Trials®	(nursing OR nurse*) AND ("care bundle*" OR bundle* OR "ventilator bundle*") AND ("ventilator-associated pneumonia" OR VAP OR PAVM) AND (prevention OR "disease prevention") AND (adherence OR compliance OR "guideline adherence")	31
MedicLatina®	(nursing OR nurse* OR "critical care nursing") AND ("care bundle*" OR bundle* OR "patient care bundle*") AND ("ventilator-associated pneumonia" OR VAP OR PAVM) AND (prevention OR "disease prevention") AND (adherence OR compliance OR "guideline adherence")	23

Study selection

A total of 122 records were identified through database searching. After the removal of 4 duplicates, 118 records remained for title and abstract screening. At this stage, 85 records were excluded for not meeting the eligibility criteria. The remaining 33 full-text articles were assessed for eligibility. Of these, 15 were excluded after full-text review, with reasons specified in the PRISMA-ScR flow diagram. At the end of the selection process, 18 studies met the eligibility criteria and were included in the final sample of this scoping review. The study selection process is presented in Figure 1, which was revised to ensure consistency with the numerical data reported in the text and greater transparency regarding exclusion reasons.

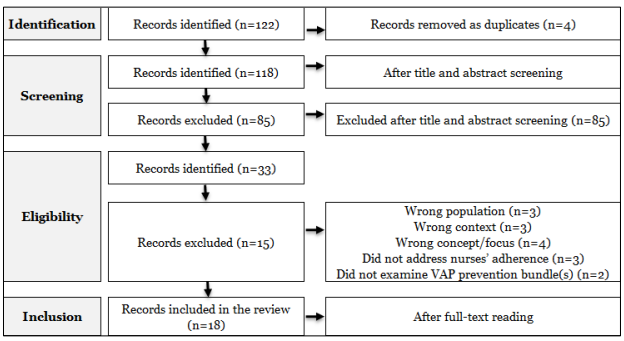

Figure 1: Flowchart of the process of identification, selection, eligibility, and inclusion of studies, developed according to PRISMA-ScR recommendations.[13]

Data extraction

Data extraction was performed using an evidence table developed by the author, based on JBI recommendations.[14] The collected data included author/year/country, title, objective, type of study, participants/population/ sample, methodology, and main results, as presented in Table 2. Any divergences between reviewers during the data extraction and analysis process were resolved by consensus or, when necessary, by consulting a third reviewer, as previously mentioned. Finally, the results were presented in descriptive and narrative form. The analytical categories presented in the discussion were constructed by the author of this review based on an inductive thematic content analysis performed from the data extracted from the included studies. This approach made it possible to group convergent content into interpretative axes relevant to understanding nurses' adherence to VAP prevention bundles and the factors influencing it, in line with the perspective on the organization, categorization, and systematic interpretation of qualitative data[14] and with the methodological recommendations for scoping reviews regarding the analysis and structured presentation of results.[15]

Data analyses and presentation

The results were analyzed descriptively and synthesized narratively. In addition, an inductive thematic content analysis was conducted to identify recurrent factors influencing nurses' adherence to VAP prevention bundles. This analytical process supported the development of the categories used to organize the findings and present the evidence in a structured manner.[14,15]

Results

The results of the process of identification, selection, eligibility, and inclusion of studies are presented according to the PRISMA-ScR flowchart. A total of 122 records were identified through database searching. After the removal of 4 duplicates, 118 records remained for title and abstract screening. At this stage, 85 records were excluded for not meeting the eligibility criteria. The remaining 33 full-text articles were assessed for eligibility. Of these, 15 were excluded after full-text review, with reasons specified in the PRISMA-ScR flow diagram. At the end of the selection process, 18 studies met the eligibility criteria and were included in the final sample of this scoping review. The study selection process is presented in Figure 1, which was revised to ensure consistency with the numerical data reported in the text and greater transparency regarding exclusion reasons. Regarding the methodological designs of the included studies, a predominance of prospective observational studies (n = 2) was observed, with the remaining designs represented by one study each. These included quasi-experimental studies, before-and-after studies, retrospective observational studies, correlational studies, cohort studies, qualitative studies, mixed-methods studies, integrative reviews, and quality improvement projects. This methodological diversity highlights the use of different research approaches to analyze adherence to VAP prevention bundles and the factors influencing it. As for the geographical distribution of publications, there was a greater concentration of studies from Brazil (n = 6). The remaining studies were distributed across 12 countries, with one publication per country: Australia, China, Slovenia, United States of America, Ethiopia, Philippines, Hungary, Oman, Poland, Portugal, United Kingdom, and Turkey. A total of 13 countries were represented, revealing an international distribution of scientific production on this topic.

Table 2 presents the characterization of the included studies, including author, year, country, objective, methodological design, participants, and main findings. Studies presented were ordered chronologically by year of publication and, when published in the same year, alphabetically by first author, in order to facilitate the visualization of the temporal development of the evidence. To support the synthesis of findings, the included studies were categorized according to the main factors reported as influencing nurses' adherence to VAP prevention bundles. These categories were developed through an inductive thematic content analysis of the extracted data and were intended to organize recurrent patterns identified across the studies.[14,15] The categories were not mutually exclusive. Therefore, some studies were included in more than one category when they addressed multiple influencing factors simultaneously, such as training, monitoring strategies, organizational conditions, and clinical outcomes.[14,15] Studies cited in the introduction were used primarily for conceptual framing. Some of them were also part of the final sample when they met the eligibility criteria and were retained after the screening process. The analysis also showed variability in the composition of the VAP prevention bundles described across the included studies. Although some preventive measures were recurrent, such as head-of-bed elevation, oral care, sedation-related practices, and monitoring procedures, the number and combination of bundle components differed between studies. This heterogeneity should be considered when interpreting the findings, as nurses' adherence may be influenced not only by contextual and organizational factors but also by differences in how bundles are defined and operationalized in each study.[2,5] The results show that the factors most frequently associated with nurses' adherence to VAP prevention bundles were clinical outcomes and care indicators, supported by 4 studies. These were followed, with 3 studies each, by team training and capacity building, implementation strategies and practice monitoring, and professional and organizational factors. Institutional resources and organizational conditions were identified in 2 studies. Taken together, these data suggest that adherence to bundles is influenced by an articulation between clinical, educational, and organizational factors. It should be noted that these values correspond to the studies explicitly used to support each category in this synthesis and do not necessarily correspond to an exhaustive recount, article by article, of the 18 included studies.

Table 2. Characterization of the studies included in the search.

Author	Country	Study Objective	Study Type	Participants / Population / Sample	Methodology	Adherence	Factors Influencing Adherence	Main results
Akdogan et al. (2017)	Turkey	Assess the effectiveness of a ventilator-associated pneumonia prevention bundle including an endotracheal tube with subglottic drainage and cuff pressure monitoring	Quality improvement project	Adult intubated patients for >48 hours (n=133; 37 intervention, 96 control)	Controlled bundle implementation with group comparison.	Low overall adherence; higher adherence for cuff pressure monitoring (50.1%), oral care and ETT-SD; no full bundle adherence	Team training; availability of ETT-SD and manometer; absence of systematic feedback; short study duration	Redução significativa da taxa de PAVM (40,82 para 22,16/1000 dias de VM; p<0,05); atraso no início da PAVM; sem impacto na mortalidade
Burja et al., 2018	Slovenia	Assess the effectiveness of a ventilator-associated pneumonia prevention bundle	Prospective correlational study	Mechanically ventilated adult patients (n=129)	Retrospective before-and-after assessment following bundle implementation.	Incidence of ventilator-associated pneumonia, early and late ventilator-associated pneumonia, mortality, duration of mechanical ventilation/intensive care unit stay	Incidence of ventilator-associated pneumonia, early and late ventilator-associated pneumonia, mortality, duration of mechanical ventilation/intensive care unit stay	Redução significativa da PAV tardia; sem diferença na mortalidade
Alecrim et al. (2019)	Brazil	Identify ventilator-associated pneumonia prevention strategies implemented in health services and classify the level of evidence of the studies.	Quantitative, descriptive, observational and cross-sectional study	Integrative review including 23 studies	Integrative literature review.	Adherence assessed in few studies; greater effectiveness when bundle adherence >90–95%	Bundle adherence, team education, indicator surveillance, feedback	Aplicação conjunta das medidas reduz significativamente a densidade de incidência de PAV.
Cruz & Martins (2019)	Portugal	Identify nursing procedures in the prevention of ventilator-associated pneumonia	Longitudinal and descriptive study	Nurses (n=20); observed procedures/observations (n=102)	Direct observation of practices and questionnaire application.	High overall adherence; lower adherence to cuff pressure checking and suctioning	Specific training; practice monitoring	Taxa de PAV de 0,3%; elevada adesão ao bundle
Dutra et al. (2019)	Brazil	Understand nursing professionals' perception of patient safety during mechanical ventilation in the prevention of ventilator-associated pneumonia.	Qualitative, descriptive and exploratory study	Nursing professionals (n=7)	Semi-structured interviews with qualitative thematic analysis.	Adherence perceived as adequate by professionals, without objective measurement.	Absence of continuing education, lack of knowledge of indicators, failures in surveillance and communication	Profissionais reconhecem riscos e realizam medidas preventivas, porém sem referência a indicadores ou notificação.
Zigart et al. (2019)	Brazil	Assess nursing team adherence to the ventilator-associated pneumonia prevention protocol	Cross-sectional and observational study	Patients (n=945)	Cross-sectional observation with bedside checklist.	High adherence to head-of-bed elevation (90.05%)	Workload; variability of practices	Incidência de PAV de 10,58%
Branco et al., 2020	Brazil	Assess nursing adherence to the ventilator-associated pneumonia prevention bundle and incidence before/after continuing education	Prospective observational surveillance study	Mechanically ventilated patients (n=302)	Continuing education with before-and-after comparison of adherence and incidence.	Nursing adherence, incidence and density of ventilator-associated pneumonia	Nursing adherence, incidence and density of ventilator-associated pneumonia	Aumento significativo da adesão e redução da densidade de PAV
Duszynska et al. (2020)	Poland	Monitor device-associated infections and assess adherence to preventive bundles in the intensive care unit	Mixed, descriptive study	ICU patients hospitalized for >48 hours (n=1353)	Prospective surveillance with monitoring of adherence to bundles.	High adherence to ventilator-associated pneumonia bundles (76.8–96.2%); variable and lower adherence in other bundles	Shows that high adherence to bundles is associated with better infection control, but adherence is not uniform	Formação contínua; vigilância ativa; feedback de desempenho
He et al. (2020)	China	Assess the impact of a national quality improvement program in intensive care units	Prospective observational study	586 hospitals and 1,587,724 ICU patients	National quality improvement program with pre-post assessment.	Significant reduction in ventilator-associated pneumonia incidence and increased bundle adherence (eg, 6-h SSC 64.9% → 76.2%)	Demonstrates that structured programs increase bundle adherence and improve process indicators	Formação estruturada; auditorias nacionais; feedback contínuo; liderança médico-enfermeiro
Madhuvu et al. (2021)	Australia	Assess use of and adherence to the ventilation bundle in two Australian intensive care units	Retrospective quasi-experimental before-and-after study	Adult mechanically ventilated patients for >48 hours (n=96)	Prospective observation of bundle adherence in two intensive care units.	Overall mean adherence of 88.3%; progressive increase in adherence from day 3 to day 5 of mechanical ventilation; lower adherence associated with greater clinical severity (high APACHE III)	Patient clinical severity; clinical contraindications; institutional policies; nursing documentation	Maior adesão aos componentes de profilaxia de TVP e úlcera péptica; adesão aumentou com os dias de ventilação mecânica
Weston Smith & Spivey, 2021	United Kingdom	Promote subglottic secretion drainage practice	Quasi-experimental time-series study	Tracheostomized ventilated patients (n=24)	Quality improvement project with PDSA cycles.	Adherence to subglottic secretion drainage	Adherence to subglottic secretion drainage	Aumento da adesão de 0% para 85,7% dos dias ventilados
Melo et al. (2021)	Brazil	Assess the impact of a collaborative project on reducing device-associated infections in the intensive care unit	Prospective descriptive observational study	Five public adult ICUs (approximately 48 beds in total)	Collaborative project with time series and indicator monitoring.	Moderate adherence to bundles (ventilator-associated pneumonia ~48%, CAUTI 71–79%, CLABSI 53–63%)	Highlights the relationship between bundle adherence and reduction of ventilator-associated pneumonia and CAUTI	Projeto colaborativo; ciclos PDSA; formação e monitorização contínua
Abad et al. (2021)	Philippines	Assess nurses' knowledge, practices and adherence to the ventilator-associated pneumonia bundle	Integrative review	Nurses (n=56) and infection control professionals (n=4)	Mixed study with questionnaire and qualitative analysis of barriers/facilitators.	Overall median adherence of 84.6%; lowest adherence to readiness-for-extubation assessment	Shows a direct relationship between nurses' knowledge and adherence to bundles	Formação insuficiente; lacunas de conhecimento; elevada rotatividade de enfermeiros
Buterakos et al. (2022)	United States of America	Assess the impact of implementing a ventilator-associated pneumonia prevention bundle, combined with nursing education and improved documentation, on ventilator-associated pneumonia incidence	Controlled prospective study	Adult patients (≥18 years) receiving mechanical ventilation for >48 hours with VAP diagnosis (n=89); ICU nurses (n=40)	Bundle implementation with team education and pre-post assessment.	High adherence after the intervention; ≥97% hand hygiene and head-of-bed elevation; improved nursing care documentation	Structured education; bedside practical assessment; audit and feedback; use of checklists; availability of resources	Redução significativa da incidência de PAVM (20,8% para 12,2%; p=0,03); redução dos dias de ventilação, tempo de internamento e necessidade de traqueostomia
Melo et al. (2022)	Brazil	Describe implementation and results of a national collaborative (PROADI-SUS) to reduce healthcare-associated infections, including ventilator-associated pneumonia associated with mechanical ventilation.	Longitudinal and descriptive study	Five adult ICUs (48 beds in total) and critically ill patients receiving invasive devices, including mechanical ventilation	National improvement collaborative with PDSA cycles and prospective monitoring.	Partial adherence to bundles (mostly >50%; 95% target not always achieved).	Continuous training, outcome monitoring, active leadership, multiprofessional teamwork (especially nursing), team motivation; difficulty involving physicians in some intensive care units.	Redução ≥30% da densidade de incidência de IRAS em pelo menos uma infeção em todas as UTIs; uma UTI atingiu redução de 50% em 18 meses.
Mogyoródi et al. (2023)	Hungary	Assess the effectiveness of a ventilator-associated pneumonia prevention bundle implemented through an educational intervention for nurses and analyze knowledge retention.	Retrospective before-and-after observational study	Mechanically ventilated patients for >48 hours (n=251) and ICU nurses (n=37)	Educational intervention with before-and-after evaluation of adherence and retention.	Full adherence increased from 16.2% to 62.2% at 3 months, but returned to baseline levels at 12 months (except for head-of-bed elevation).	Team training, audit and supervision; loss of knowledge retention over time.	Redução da incidência de PAVM de 29,3 para 15,3/1000 dias de ventilação; redução significativa do risco (HR 0,41).
Debas et al. (2024)	Ethiopia	Assess adherence to ventilator-associated pneumonia prevention bundles in intensive care units	Qualitative, descriptive and exploratory study	Adult patients receiving mechanical ventilation for >48 hours (n=300)	Prospective assessment of bundle adherence in ventilated patients.	Overall adherence of 70%; high adherence to head-of-bed elevation, peptic ulcer and deep vein thrombosis prophylaxis; zero adherence to oral hygiene with chlorhexidine; low adherence to humidification and daily sedation	Lack of training, knowledge limitations, lack of equipment, resource-limited setting	Cumprimento satisfatório em medidas básicas; falhas críticas em práticas-chave de enfermagem
Al-Harthi et al., 2025	Oman	Assess nurses' adherence to the ventilator-associated pneumonia bundle and its relationship with outcomes	Controlled pre-post cohort study	echanically ventilated patients for ≥48 hours (n=103)	Prospective correlational assessment of adherence and clinical outcomes.	Nurses' adherence, ventilator-associated pneumonia, length of stay, mechanical ventilation days, costs	Nurses' adherence, ventilator-associated pneumonia, length of stay, mechanical ventilation days, costs	Adesão média 69%; maior adesão associada a menos PAV, LOS, dias VM e custos

Discussion

The analysis of the included studies showed that adherence to bundles does not depend exclusively on professionals' technical knowledge, but also on the existence of implementation and monitoring strategies, resource availability, institutional support, and the professional and organizational dynamics present in practice settings. In addition, the findings suggest that higher levels of adherence tend to be associated with better clinical and care outcomes, reinforcing the relevance of this topic for the safety of critically ill patients and for the quality of nursing care provided in intensive care units. Five central categories were identified to understand this phenomenon: team training and capacity building; implementation strategies and practice monitoring; institutional resources and organizational conditions; professional and organizational factors influencing adherence; and clinical outcomes and care indicators.

Team training and capacity building

Structured training and continuing education emerge as central factors for improving adherence to VAP prevention bundles. The included studies suggest that the acquisition of knowledge and the development of specific skills favor the more consistent implementation of preventive practices, especially when training is directed at the concrete components of the bundles and their application in the real care context. In this regard, it was found that an educational intervention directed at the nursing team significantly increased compliance with the bundle, although the authors also observed some loss of this gain over time.[16] In line with these findings, improvements in adherence to specific preventive measures were observed after an educational strategy in the intensive care setting[17], while other authors identified knowledge gaps regarding bundle components and defended the need for formal training and regular educational sessions.[18] These results suggest that training should not be understood as a one-off intervention, but rather as a continuous process of professional capacity building. The analyzed evidence indicates that lack of specific training, limitations in knowledge, and the decline in retention of content over time may compromise the sustainability of the improvements achieved. Thus, higher levels of knowledge appear to be associated with greater adherence to bundles, reinforcing the idea that structured education and continuous training are essential pillars for consolidating skills, reducing gaps, and promoting sustained adherence to VAP prevention measures. In view of these findings, the studies analyzed reinforce the importance of implementing structured and continuous training strategies as a relevant component for improving nurses' knowledge and promoting greater adherence to VAP prevention bundles.[16-18]

Implementation strategies and practice monitoring

The results of the review show that adherence to preventive measures tends to be more consistent when implementation is accompanied by organizational strategies of continuous monitoring and evaluation. Audits, feedback to teams, supervision, checklists, surveillance of indicators, and the integration of interventions into nursing records emerge as mechanisms facilitating the systematic application of bundles. The introduction of a care bundle with formal prescription, prompts for subglottic drainage, and a care plan per shift substantially improved the documentation of this practice.[19] In line with these findings, the importance of regular audits on bundle implementation was highlighted, with a recommendation to incorporate preventive measures into daily nursing records and into frequent audit cycles.[19,20] These data show that continuous monitoring allows not only the identification of implementation failures, but also promotes greater professional accountability and reinforces the reliability of care provided. Bedside practical assessment and the use of structured instruments seem to favor the standardization of practices and their maintenance over time. Thus, the studies support that the adoption of systematic monitoring and evaluation strategies is a relevant element in improving adherence to bundles and consolidating more consistent and evidence-based nursing practice. In this sense, it becomes pertinent to strengthen the implementation of regular audits, systematic feedback, checklists, and standardized records as strategies facilitating adherence to recommended VAP prevention practices.[19-21]

Institutional resources and organizational conditions

Adherence to VAP prevention bundles does not depend exclusively on professionals' knowledge or motivation, but is also strongly conditioned by the availability of resources and the organizational conditions existing in institutions. In this sense, the analyzed studies show that the operationalization of certain interventions requires equipment, specific materials, and adequate institutional support. The implementation of a bundle that included an endotracheal tube with subglottic drainage and cuff pressure monitoring was associated with a reduction in the incidence of VAP, but it was also emphasized that this implementation depended on the prior availability of devices and institutional support.[22] Similarly, it was found that, in the studied context, some practices were not applicable due to unavailability of resources and limitations of the care setting.[23] These findings reinforce the idea that structural limitations and resource-scarce contexts may compromise adherence to recommendations and condition the effective implementation of preventive measures. In addition to the availability of equipment, institutional policies

and organizational support also seem to play a relevant role, insofar as they facilitate the integration of interventions into care processes and sustain the continuity of practices.

Thus, the evidence suggests that resource availability and institutional support directly influence bundle implementation and nurses' adherence to VAP prevention measures. In light of these results, the importance of ensuring favorable organizational conditions, availability of equipment, and institutional support as essential elements for the effective implementation of preventive interventions is reinforced.[22,23]

Professional and organizational factors influencing adherence

The review also allowed the identification of a set of human and organizational factors that facilitate or hinder adherence to bundles. These include active leadership, multiprofessional work, team motivation, workload, staff turnover, variability of practices, communication failures, and the absence of systematic feedback. An average compliance of 69% was found, and compliance decreased over the length of hospital stay, suggesting difficulties in maintaining adherence throughout the care pathway.[24] In turn, it was highlighted that insufficient knowledge about specific bundle components and nurse turnover may compromise the consolidation of institutional practices. Adherence below the desired level was associated with the absence of regular professional development programs and with the limitations of the care context.[25] These results show that adherence should not be interpreted solely as an individual professional choice, but as the reflection of a broader organizational context. Environments characterized by greater team stability, better multiprofessional articulation, more structured communication, and more present leadership tend to favor the consistent implementation of bundles. In contrast, care overload, communication failures, and the absence of strategies to support practice may compromise the maintenance of preventive measures.[23] In this sense, the studies suggest that human and organizational factors significantly influence nurses' adherence to VAP prevention practices and should be considered when designing quality improvement strategies. Thus, it becomes relevant to promote active leadership, teamwork, effective communication, and organizational conditions that support practice, reducing the constraints that hinder sustained adherence to bundles.[23-25]

Clinical outcomes and care indicators

The included studies consistently point to an association between greater adherence to bundles and better clinical and care outcomes. Among the most frequently assessed outcomes are the incidence of VAP, VAP density, the distinction between early and late VAP, mortality, duration of mechanical ventilation, ICU stay, length of hospital stay, and hospital costs. Authors demonstrated a reduction in the incidence density of pneumonia and a lower risk of developing VAP after the implementation of the preventive program.[22,26] A decrease in VAP rates after the implementation of a standardized, evidence-based protocol associated with a bundle and nursing education was also reported.[26] It was observed that greater bundle compliance was associated with shorter length of stay, fewer days of mechanical ventilation, and lower hospital costs, with average adherence being higher in patients who did not develop VAP.[24] Similarly, a reduction in VAP incidence was demonstrated after the implementation of a bundle that included subglottic drainage, cuff pressure monitoring, and oral hygiene with chlorhexidine.[22] Together, these data suggest that adherence to bundles should be understood not only as a process indicator, but also as an element with potential impact on care outcomes and the safety of critically ill patients. Although not all studies demonstrate significant changes in all outcomes, the overall trend points to clinical and organizational benefits associated with the consistent implementation of preventive measures. Thus, the analyzed evidence reinforces the relevance of nurses' adherence to bundles as a fundamental component of the quality of care and of VAP prevention in intensive care settings. In light of these results, the studies support that strengthening adherence to bundles should be valued as a strategy with the potential to reduce the incidence of VAP and improve relevant clinical and care indicators.[22,24,26]

Conclusions

The findings of this scoping review show that nurses' adherence to ventilator-associated pneumonia prevention bundles is influenced by multiple and interrelated factors, particularly team training, implementation and monitoring strategies, organizational conditions, institutional support, and professional dynamics within intensive care settings. Overall, the evidence suggests that sustained adherence is favored by structured education, audit and feedback processes, practice monitoring, and the availability of adequate resources, whereas workload, staff turnover, communication failures, and resource limitations may hinder the implementation of preventive measures. The review also indicates that greater adherence tends to be associated with better clinical and care outcomes. These findings reinforce the importance of integrated quality improvement strategies to support safe and evidence-based nursing practice in intensive care units.

Study limitations

This scoping review has some limitations that should be considered when interpreting the results. First, the included studies were heterogeneous regarding methodological

designs, settings, participants, and analytical focuses, which limits the direct comparability of findings. Second, not all studies specifically addressed the factors associated with nurses' adherence to VAP prevention bundles, and some were included because of their contextual contribution to understanding the phenomenon. In addition, only studies published in Portuguese, English, and Spanish were considered, which may have led to the exclusion of relevant evidence published in other languages. It should also be noted that, as this is a scoping review, the objective focused on mapping the available evidence, and no critical appraisal of the methodological quality of the included studies was performed. Finally, the review protocol was registered at a stage subsequent to the initial planning, which constitutes a limitation of the methodological process, although it was made publicly available on the Open Science Framework.

Contributions to clinical practice

The results of this scoping review may contribute to strengthening evidence-based nursing practice by identifying interventions and strategies that promote nurses' adherence to ventilator-associated pneumonia prevention bundles in hospital settings. Mapping the available evidence makes it possible to recognize factors conditioning adherence, barriers to implementation, and elements facilitating the consistent incorporation of these bundles into clinical practice. This knowledge may support the review and updating of institutional protocols, as well as the development of continuing education programs and clinical supervision strategies aimed at improving the quality of care. In addition, the results of this review may support the definition of organizational policies and practices directed at patient safety, promoting standardization of care and the use of preventive interventions based on the best available evidence. More broadly, it is expected that this review will constitute a relevant contribution to the implementation, monitoring, and evaluation of continuous quality improvement strategies, with potential impact on reducing the incidence of VAP, improving clinical outcomes, and optimizing health resources.

All data underlying this study are included in the article and its supplementary materials.

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