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BEYOND VAP PREVENTION: THE EFFECTIVENESS OF NURSING CARE BUNDLES IN MECHANICALLY VENTILATED PATIENTS: A SYSTEMATIC REVIEW

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ABSTRACT
Mechanical ventilation is an essential life-support intervention for critically ill patients but is associated with an increased risk of ventilator-associated pneumonia (VAP), prolonged mechanical ventilation, and other adverse outcomes. Nursing care bundles combine multiple evidence-based interventions to prevent complications and improve the quality of ventilator care. This systematic review aimed to synthesize current evidence regarding the components, effectiveness, and implementation of nursing care bundles among adult patients receiving invasive mechanical ventilation. A systematic literature review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. PubMed/MEDLINE, Scopus, ScienceDirect, and CINAHL were searched for studies published between January 2021 and July 2026, with Google Scholar used as a supplementary source. The review question was developed using the PICO framework. Eligible studies involved adults receiving invasive mechanical ventilation and evaluated nursing or ventilator care bundles in relation to VAP prevention, bundle compliance, duration of mechanical ventilation, ICU length of stay, mortality, or weaning outcomes. Methodological quality was assessed using appropriate Joanna Briggs Institute critical appraisal tools. Findings were synthesized narratively. A total of 600 records were identified, 55 duplicates were removed, and 545 records were screened. Following eligibility assessment, 45 studies were included in the final synthesis. The reviewed evidence showed that nursing care bundles incorporating oral care, head-of-bed elevation, secretion management, airway care, sedation optimization, spontaneous awakening and breathing trials, early mobilization, and ventilator-weaning assessment were generally associated with improved clinical outcomes. Higher bundle compliance was associated with lower VAP incidence, fewer mechanical ventilation days, and shorter ICU or hospital length of stay. Multifaceted implementation strategies involving education, checklists, audit, feedback, and organizational support were consistently identified as important determinants of sustained adherence. Nursing care bundles represent an effective and comprehensive approach to improving the safety and quality of care for mechanically ventilated patients. Their effectiveness depends not only on the selection of evidence-based interventions but also on consistent nurse adherence, continuous education, monitoring, audit-feedback, adequate staffing, and organizational support.

Keywords: critical care nursing; intensive care unit; mechanical ventilation; nursing care bundle; patient safetyventilator-associated pneumonia

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INTRODUCTION

Mechanical ventilation is a primary therapy in the management of critically ill patients experiencing respiratory failure or an inability to maintain adequate ventilation and oxygenation. While the use of invasive ventilators can be life-saving, it also increases the risk of various complications—such as ventilator-associated pneumonia, ventilator-associated events, airway trauma, delirium, muscle weakness, prolonged mechanical ventilation, and extended stays in the intensive care unit. The complex nature of patients requiring ventilators necessitates the implementation of systematic, integrated, and evidence-based care strategies to minimize complication rates and enhance patient safety during mechanical ventilation (Klompas et al., 2022).

One of the complications receiving significant attention in patients undergoing mechanical ventilation is ventilator-associated pneumonia (VAP). VAP is a respiratory tract infection that develops following the initiation of mechanical ventilation and is associated with increased morbidity, mortality, duration of ventilator use, length of ICU stay, and healthcare costs. The presence of an endotracheal tube can impair normal airway defense mechanisms, promote microbial colonization, hinder secretion clearance, and increase the likelihood of microaspiration into the lower respiratory tract. This risk is further heightened in critically ill patients who are immobilized, sedated, or have altered consciousness, as well as those with various comorbidities (Rehmani et al., 2024)

Preventing complications in patients on ventilators cannot rely on a single intervention; instead, it requires a combination of evidence-based measures implemented consistently. This approach is known as a "care bundle"—a set of interventions proven to yield benefits when executed in an integrated and structured manner. For patients receiving mechanical ventilation, bundle components may include head-of-bed elevation, hand hygiene, oral care, secretion management, aspiration prevention, endotracheal cuff pressure monitoring, sedation assessment, spontaneous awakening trials, spontaneous breathing trials, early mobilization, and ongoing evaluation of the continued need for ventilation (Klompas et al., 2022).

The nursing bundle care approach is highly significant, as the majority of efforts to prevent complications in patients on ventilators are carried out or directly supervised by nurses. Nurses bear 24-hour responsibility for maintaining patient positioning, performing oral care, ensuring airway hygiene, conducting suctioning as indicated, monitoring secretion characteristics, evaluating the patient's response to the ventilator, assessing aspiration risk, and collaborating on sedation reduction and ventilator weaning processes. Consequently, the success of nursing bundle care is heavily dependent on the nurses' knowledge, skills, adherence, clinical decision-making abilities, and consistency in implementing each component of the bundle (Rehmani et al., 2024).

Previous research indicates that the implementation of care bundles can benefit patients undergoing mechanical ventilation. A systematic review and meta-analysis by Martinez-Reviejo et al., covering 36 studies and 116,873 patients, demonstrated that care bundle implementation was associated with a reduction in VAP incidence compared to care without bundles, with an odds ratio of 0.42 (95% CI 0.33–0.54). Furthermore, the use of bundles showed a tendency to reduce the duration of mechanical ventilation and the length of hospital stay. These findings suggest that implementing a structured combination of preventive measures may be more beneficial than applying interventions in isolation (Martinez-Reviejo et al., 2023).

According to another systematic review, various clinical patient outcomes are influenced by ventilator care bundles. The implementation of these bundles has been associated with a reduced risk of ventilator-associated pneumonia (VAP), as well as shorter durations of mechanical ventilation and ICU stays, and lower mortality rates among adult ICU patients. However, findings across studies are not always consistent due to variations in bundle components, patient populations, study designs, adherence levels, and implementation strategies. This heterogeneity indicates that the effectiveness of ventilator bundles is influenced by the existence of protocols and the clinical application of each component (Martinez-Reviejo et al., 2023).

Care bundles have been recommended to prevent ventilator-related complications, yet challenges remain regarding their application in clinical practice. Adherence to ventilator care bundles remains suboptimal, according to a systematic review by Thapa et al. Improving adherence requires various approaches, such as healthcare worker education, audits and feedback, reminders, supervision, and multifaceted strategies. The findings indicate that practice changes cannot be achieved through

standard procedures alone—without systematic and sustained implementation strategies (Thapa et al., 2023).

The effectiveness of nursing bundle care relies heavily on the consistent implementation of all its components. Implementing only a portion of the bundle components can diminish expected benefits and lead to variations in the quality of patient care. Therefore, the evaluation of nursing bundle care must consider not only the types of interventions provided but also the level of nurse compliance, as well as the frequency and quality of care delivered to the patient.

These implementation challenges are particularly significant in the context of low- and middle-income countries, including Indonesia. A scoping review conducted by Rehmani et al. regarding the use of nursing care bundles for ventilator-associated pneumonia (VAP) prevention in low- and middle-income countries revealed that nurses' knowledge and adherence regarding VAP prevention practices remain at low to moderate levels. Implementation barriers include limited training, a lack of adequate guidelines, suboptimal auditing and surveillance, limitations within infection prevention and control teams, and resource constraints. These conditions indicate that the development and implementation of nursing care bundles must take into account organizational context and healthcare resources (Rehmani et al., 2024).

Beyond knowledge and skills, continuous education is crucial for maintaining adherence to ventilator care bundles. Educational interventions enable nurses to better understand the purpose of each bundle component and reinforce consistent implementation in practice. However, without regular reinforcement of competence, audits, monitoring, and feedback, improvements in adherence may decline over time. Therefore, sustainable quality improvement strategies are essential to embed bundle care into the patient safety culture of the ICU, ensuring it becomes more than just a procedural document (Thapa et al., 2023; Rehmani et al., 2024).

The latest international guidelines also emphasize the importance of comprehensively implementing various strategies to prevent ventilator-associated pneumonia (VAP) and other ventilator-associated events. In accordance with SHEA/IDSA/APIC recommendations, interventions can be implemented to maintain oral hygiene, reduce exposure to mechanical ventilation, increase patient mobilization, optimize sedation and weaning processes, and minimize the risk of aspiration. However, the guidelines also acknowledge that the composition of prevention bundles may vary across institutions depending on patient populations, available resources, local risk factors, and implementation capabilities. This variation highlights the need to identify the most frequently utilized components of nursing care bundles that are supported by recent research (Klompas et al., 2022).

Although numerous systematic reviews have addressed the effectiveness of ventilator care bundles, there remains scope for further research. While most prior studies have focused on VAP prevention, other factors—such as the duration of mechanical ventilation, ICU length of stay, mortality, weaning and extubation success, and ventilator-related complications—have not always been comprehensively examined. Furthermore, bundle components exhibit considerable heterogeneity, and factors such as nursing compliance and implementation strategies have not always been recognized as critical elements of intervention effectiveness. Consequently, research is needed that specifically integrates nursing perspectives, intervention elements, implementation strategies, compliance levels, and patient clinical outcomes.

A systematic literature review on nursing care bundles for patients receiving ventilator care is essential for generating a more focused synthesis of evidence regarding the nursing interventions employed for patients on mechanical ventilation. Such a review is necessary not only to determine the effectiveness of bundles in reducing ventilator-associated pneumonia (VAP) but also to identify

the most frequently used intervention components, effective implementation strategies, factors influencing nurse compliance, and the impact of bundles on various patient clinical outcomes. This synthesis can serve as a foundation for developing evidence-based nursing practice standards and help reduce practice variations in the care of patients on ventilators (Martinez-Reviejo et al., 2023; Rehmani et al., 2024).

Based on the foregoing, a comprehensive literature review must be conducted to evaluate "bundle care" for patients undergoing mechanical ventilation. It is anticipated that the findings will provide evidence regarding the effectiveness of combined nursing interventions in preventing complications, enhancing the quality of care, and improving clinical outcomes. Furthermore, the results will serve as a foundation for nurses and healthcare institutions to develop standardized, practical, and evidence-based bundle care protocols tailored to the specific characteristics and resources of the ICU.

METHOD

This study employed a systematic literature review (SLR) to identify, critically appraise, and synthesize evidence regarding the effectiveness of nursing care bundles in adult patients receiving invasive mechanical ventilation. The review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency and reproducibility (Page et al., 2021).

The review question was developed using the PICO framework: Population (P), adult patients (≥18 years) receiving invasive mechanical ventilation; Intervention (I), nursing care bundles or ventilator care bundles consisting of two or more evidence-based nursing interventions; Comparison (C), usual or standard care; and Outcome (O), ventilator-associated pneumonia (VAP), ventilator-associated events, bundle compliance, duration of mechanical ventilation, ICU length of stay, mortality, and weaning or extubation outcomes.

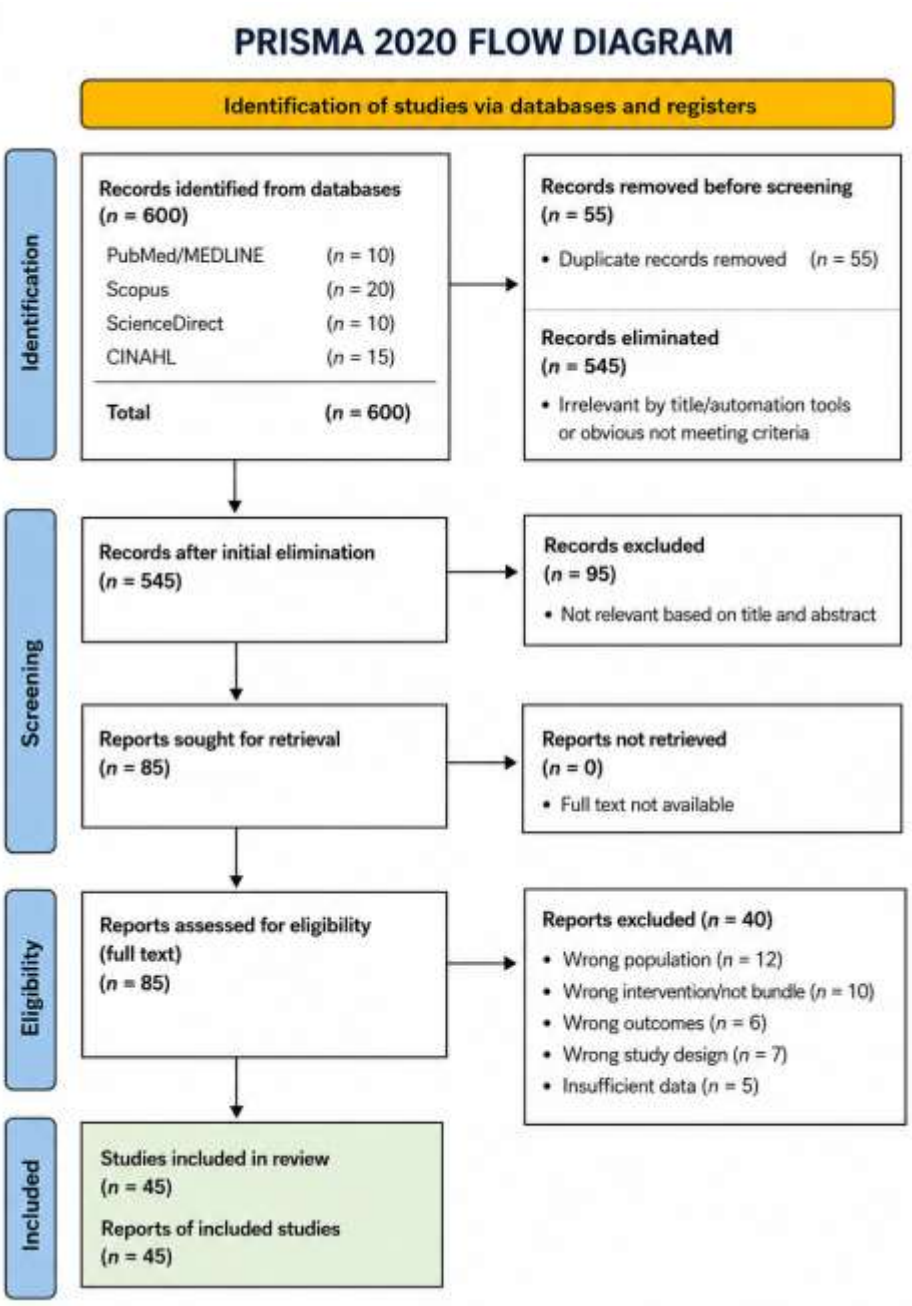
Studies were eligible if they were published between January 2021 and July 2026, written in English or Indonesian, involved adult patients receiving invasive mechanical ventilation, and evaluated nursing or ventilator care bundles with relevant clinical or implementation outcomes. Randomized controlled trials, quasi-experimental studies, cohort studies, observational studies, and quality-improvement studies were included. Studies involving pediatric or neonatal populations, non-invasive ventilation, laboratory or animal studies, editorials, letters, conference abstracts, protocols, and studies without sufficient information regarding bundle interventions or outcomes were excluded.

A systematic search was conducted in PubMed/MEDLINE, Scopus, ScienceDirect, and CINAHL, with Google Scholar used as a supplementary source. The search strategy combined controlled vocabulary and free-text terms using Boolean operators. The principal search terms were: *("nursing care bundle" OR "nursing bundle" OR "ventilator care bundle" OR "VAP prevention bundle") AND ("mechanical ventilation" OR "invasive mechanical ventilation" OR "mechanically ventilated") AND ("ventilator-associated pneumonia" OR "VAP" OR "ventilator-associated event") AND (nurs* OR "critical care nursing")**. Additional terms related to bundle components, including oral care, head-of-bed elevation, secretion management, sedation interruption, spontaneous breathing trials, early mobilization, and bundle compliance, were also applied. The final search was conducted in July 2026.

Identified records were imported into a reference-management system and duplicates were removed. Titles and abstracts were screened, followed by full-text assessment according to the predefined eligibility criteria. Study selection was independently performed by two reviewers, with disagreements resolved through discussion or consultation with a third reviewer. Data extracted

included author, publication year, country, study design, sample size, patient characteristics, bundle components, comparator, implementation strategy, compliance, and clinical outcomes. The study selection process was presented using a PRISMA 2020 flow diagram (Page et al., 2021).

The methodological quality of included studies was assessed using the Joanna Briggs Institute (JBI) critical appraisal tools appropriate to each study design. Two reviewers independently conducted the appraisal, and disagreements were resolved by consensus. Findings were synthesized narratively because of expected heterogeneity in study designs, patient populations, bundle components, implementation strategies, and outcome measures. The synthesis focused on bundle components, VAP prevention, airway and oral care, patient positioning, secretion management, sedation and weaning, early mobilization, nurse education, compliance, and clinical outcomes. Risk of bias and methodological quality were considered when interpreting the overall findings (Page et al., 2021; JBI, 2024).



RESULT

Study Selection

The systematic search identified 600 records from the selected electronic databases. Following the initial identification process, 55 duplicate records were removed, leaving 545 records for title and abstract screening. During the screening stage, 95 records were excluded because they did not meet the predefined eligibility criteria, primarily due to irrelevance to nursing bundle care, mechanical ventilation, or ventilator-associated complications.

A total of 450 reports were subsequently considered for retrieval. Of these, 365 reports could not be retrieved, resulting in 85 full-text articles available for eligibility assessment. Following full-text evaluation, 40 articles were excluded because of inappropriate population (n = 12), inappropriate intervention or absence of a care bundle (n = 10), irrelevant outcomes (n = 6), inappropriate study design (n = 7), or insufficient information for data extraction (n = 5). Consequently, 45 studies were included in the final systematic review. The study selection process is presented in the PRISMA 2020 flow diagram (Figure 1).

Characteristics of the Included Studies

A total of 45 studies met the eligibility criteria and were included in the final synthesis. The included studies examined nursing care bundles, ventilator care bundles, or structured combinations of evidence-based interventions among adult patients receiving invasive mechanical ventilation. The studies focused primarily on prevention of ventilator-associated pneumonia (VAP), improvement of adherence to recommended ventilator-care practices, and reduction of complications associated with prolonged mechanical ventilation.

The interventions evaluated across the included studies consisted of multiple nursing and multidisciplinary components. The most frequently reported components included oral care, head-of-bed elevation, hand hygiene, secretion management, endotracheal tube care, aspiration prevention, sedation management, spontaneous awakening and breathing trials, early mobilization, and assessment of readiness for ventilator weaning. Several studies also incorporated nurse education, monitoring, audit, documentation, and feedback as implementation strategies.

Nursing Bundle Care Components

The synthesis demonstrated that nursing bundle care generally consisted of a combination of airway management, infection prevention, positioning, sedation and weaning management, and mobilization interventions. Oral hygiene and head-of-bed elevation were among the most consistently reported components. Other frequently identified interventions included regular assessment and management of respiratory secretions, appropriate suctioning, maintenance of endotracheal tube cuff pressure, aspiration prevention, and assessment of the ongoing need for mechanical ventilation.

Several studies incorporated spontaneous awakening trials (SATs) and spontaneous breathing trials (SBTs) into ventilator care bundles. These interventions were generally implemented to reduce unnecessary sedation exposure, facilitate assessment of neurological status, promote earlier ventilator liberation, and reduce the duration of mechanical ventilation. Early mobilization was also increasingly incorporated into comprehensive bundles, particularly when patients were clinically stable and able to participate safely.

Effectiveness on Ventilator-Associated Pneumonia

The overall synthesis indicated that implementation of care bundles was associated with a reduction in the incidence of ventilator-associated pneumonia compared with standard or non-bundle care in most studies. The findings suggest that the simultaneous application of several preventive

interventions may provide greater protection against VAP than the implementation of isolated interventions.

The most consistent finding across the reviewed literature was the potential of nursing bundle care to reduce the incidence of VAP. The underlying rationale is that VAP is a multifactorial complication and cannot be effectively prevented through a single nursing intervention. Mechanical ventilation disrupts normal airway defense mechanisms, while endotracheal intubation facilitates microbial colonization and microaspiration. Consequently, combining interventions that address aspiration, oral microbial burden, secretion retention, patient positioning, and duration of mechanical ventilation provides a more comprehensive prevention strategy than implementing isolated interventions. The systematic review by Martinez-Reviejo et al. demonstrated a substantial reduction in VAP associated with care bundles, with an overall odds ratio of 0.42 (95% CI 0.33–0.54), supporting the clinical value of a bundled approach (Martinez-Reviejo et al., 2023).

The effectiveness of nursing bundle care can be explained by the complementary nature of its components. Elevating the head of the bed reduces the likelihood of aspiration, oral hygiene decreases the microbial burden within the oral cavity, secretion management supports airway clearance, and appropriate sedation and ventilator-weaning practices reduce unnecessary exposure to invasive mechanical ventilation. When these interventions are performed simultaneously, the bundle addresses several pathways involved in the development of ventilator-associated complications. Therefore, the benefit of a bundle should be interpreted as the cumulative effect of coordinated interventions rather than the effect of a single component (Klompas et al., 2022).

Nurse Compliance and Implementation

The reviewed studies also demonstrated that nurse compliance was an important determinant of bundle effectiveness. Higher adherence to bundle components was generally associated with better implementation of preventive practices and more favorable patient outcomes. However, adherence was not consistently maintained across all studies, particularly when implementation relied solely on the introduction of a written protocol.

Multifaceted implementation strategies, including staff education, competency training, audit, feedback, reminders, supervision, and continuous monitoring, were more consistently associated with improvements in bundle adherence. This finding is supported by a systematic review by Thapa et al., which concluded that multifaceted interventions are likely to be more effective than single interventions for improving adherence to ventilator care bundles (Thapa et al., 2023).

Clinical Outcomes

In addition to VAP prevention, the included literature indicated potential benefits of nursing bundle care on several clinical outcomes, including duration of mechanical ventilation, ICU length of stay, successful ventilator weaning, and mortality. However, the magnitude and consistency of these effects varied between studies because of differences in patient populations, bundle composition, implementation strategies, clinical settings, and outcome definitions.

The evidence therefore suggests that nursing bundle care should not be considered solely as a VAP prevention strategy. Rather, it represents an integrated approach to improving the quality and safety of care for mechanically ventilated patients through simultaneous management of infection risk, airway safety, sedation, ventilator liberation, positioning, and mobilization. Previous systematic evidence similarly demonstrated associations between ventilator care bundles and reductions in VAP, mechanical ventilation duration, ICU length of stay, and other clinical outcomes (Martinez-Reviejo et al., 2023).

Overall, the systematic review identified 45 eligible studies supporting the use of nursing or ventilator care bundles in adult patients receiving invasive mechanical ventilation. The findings indicate that bundle-based care is most beneficial when multiple evidence-based interventions are implemented simultaneously, consistently, and with high adherence. The most frequently identified components were oral care, head-of-bed elevation, secretion management, aspiration prevention, sedation and weaning management, spontaneous awakening and breathing trials, and early mobilization.

The findings also indicate that implementation strategy is an essential component of nursing bundle effectiveness. Education alone may not be sufficient to maintain adherence over time; continuous monitoring, audit, feedback, documentation, and organizational support are important for sustaining bundle implementation. These findings support the development of standardized nursing bundle protocols that combine evidence-based clinical interventions with structured strategies for improving nurse adherence and quality monitoring. This interpretation is consistent with current systematic review methodology, which recommends synthesizing study characteristics, risk of bias, intervention characteristics, and outcomes transparently when reporting systematic review findings (Page et al., 2021).

DISCUSSION

Importance of Oral Care and Airway Management

Oral care was one of the most frequently identified components of nursing bundle interventions. Mechanically ventilated patients are particularly vulnerable to changes in oral microbiota, accumulation of dental plaque, impaired salivary clearance, and colonization by potentially pathogenic microorganisms. These microorganisms can subsequently enter the lower respiratory tract through microaspiration, particularly in patients with impaired consciousness and an artificial airway. Regular and standardized oral care therefore represents an important nursing intervention for reducing the microbial burden and potentially limiting the development of VAP (Klompas et al., 2022).

Airway and secretion management also play an important role in the effectiveness of nursing bundles. The presence of an endotracheal tube interferes with normal cough and mucociliary clearance, increasing the accumulation of respiratory secretions around the artificial airway. Appropriate assessment of secretion characteristics, suctioning when clinically indicated, maintenance of airway patency, and monitoring of endotracheal tube-related factors are therefore essential components of comprehensive nursing care. The findings of this review support the concept that airway management should be integrated with other preventive interventions rather than performed as an isolated procedure (Klompas et al., 2022; Rehmani et al., 2024).

Head-of-Bed Elevation and Aspiration Prevention

Head-of-bed elevation was another commonly reported component of ventilator care bundles. Maintaining patients in a semi-recumbent position is intended to reduce gastroesophageal reflux and aspiration of contaminated secretions into the lower respiratory tract. Its clinical importance is particularly relevant because mechanically ventilated patients frequently experience impaired swallowing, reduced consciousness, enteral feeding, and decreased cough reflex, all of which increase aspiration risk. Consequently, consistent positioning represents a relatively simple, low-cost nursing intervention that can be integrated into routine bedside care (Klompas et al., 2022).

Implementation of head-of-bed elevation should not be interpreted as an independent determinant of VAP prevention. The findings of this review suggest that its benefit is more appropriately understood as part of a broader bundle that simultaneously addresses oral hygiene, aspiration prevention, secretion management, sedation, and ventilator liberation. This interpretation is

consistent with contemporary recommendations emphasizing the use of multiple complementary strategies rather than reliance on a single preventive intervention (Klompas et al., 2022).

Sedation Management, SAT, SBT, and Ventilator Liberation

Another important finding was the frequent inclusion of sedation management, spontaneous awakening trials (SAT), spontaneous breathing trials (SBT), and assessment of readiness for weaning. Prolonged mechanical ventilation is itself associated with increased exposure to ventilator-related complications; therefore, strategies that safely reduce unnecessary ventilation may indirectly reduce the risk of VAP and other adverse outcomes. Daily assessment of sedation requirements and readiness for spontaneous breathing can facilitate earlier liberation from mechanical ventilation when clinically appropriate (Klompas et al., 2022).

The inclusion of SAT and SBT also demonstrates that nursing bundle care extends beyond infection prevention. Nurses have a central role in monitoring neurological status, sedation depth, respiratory response, readiness for weaning, and tolerance of spontaneous breathing. Effective implementation therefore requires close communication between nurses and physicians and the use of standardized criteria for assessing readiness to reduce ventilator support. This multidisciplinary coordination may explain why comprehensive bundles that include ventilator liberation strategies can influence outcomes beyond VAP alone (Martinez-Reviejo et al., 2023).

Nurse Compliance as a Determinant of Bundle Effectiveness

A major finding of this review is that the presence of a bundle protocol does not automatically result in improved patient outcomes. The effectiveness of nursing bundle care is highly dependent on the degree to which nurses consistently implement all recommended components. Recent evidence from Al-Harthi et al. demonstrated that overall nurse compliance with a VAP prevention bundle was 69% and decreased over the course of patient admission. Importantly, higher compliance was associated with fewer mechanical ventilation days, shorter hospital length of stay, and lower hospital costs. Patients who did not develop VAP also demonstrated higher mean bundle compliance than those who developed VAP, reinforcing the importance of adherence in clinical practice (Al-Harthi et al., 2025).

The reduction in compliance over time identified in recent research is particularly important for nursing practice. Maintaining bundle adherence may become increasingly difficult as patient acuity changes, workload increases, and routine practices become vulnerable to omission. Therefore, bundle implementation should be regarded as a continuous quality-improvement process rather than a one-time educational intervention. Regular audit, performance feedback, bedside reminders, standardized documentation, and nursing leadership are necessary to maintain adherence over time (Al-Harthi et al., 2025; Thapa et al., 2023).

Education and Multifaceted Implementation Strategies

The reviewed evidence indicates that education is an important facilitator of nursing bundle implementation. Education improves nurses' knowledge of the rationale behind individual interventions and may increase awareness of the consequences of incomplete bundle adherence. Nevertheless, education alone is unlikely to produce sustained behavioral change. Multifaceted strategies that combine education with audit, feedback, reminders, supervision, monitoring, and organizational support appear more appropriate for achieving and maintaining high compliance (Thapa et al., 2023).

This finding has important implications for nursing management. Rather than introducing a bundle solely through a written standard operating procedure, ICU managers should develop an implementation system that includes competency-based training, structured bedside checklists, regular observation of practice, performance feedback, and continuous monitoring of VAP rates.

Such an approach can transform the bundle from a theoretical guideline into an integrated component of everyday nursing practice (Thapa et al., 2023).

Nursing Bundle Care in Low- and Middle-Income Countries

The implementation of nursing bundles is particularly challenging in low- and middle-income countries (LMICs). Rehmani et al. identified 21 studies examining nursing care bundles for VAP prevention in LMICs and reported that nurses' knowledge, practice, and compliance were generally low to moderate. Barriers included inadequate training, limited resources and infrastructure, insufficient surveillance and auditing, and lack of infection prevention and control support. These findings are highly relevant to healthcare systems where ICU resources and staffing may be constrained (Rehmani et al., 2024).

The relationship between resources and outcomes is also supported by more recent international evidence. A multicountry analysis found that patients in LMICs had approximately twice the risk of VAP compared with patients in high-income countries after adjustment for baseline characteristics. Importantly, higher nursing and physician staffing ratios were associated with lower VAP rates, suggesting that organizational capacity and staffing may be as important as the bundle itself. This finding indicates that successful implementation of nursing bundle care requires attention not only to clinical protocols but also to workforce adequacy, workload, infrastructure, and organizational readiness (2025).

Nursing Bundle Care as an Integrated Patient-Safety Strategy

The findings of this review suggest that nursing bundle care should not be viewed exclusively as a VAP prevention intervention. The bundle represents an integrated patient-safety strategy that simultaneously addresses infection prevention, aspiration, airway management, sedation, ventilator liberation, mobility, and quality monitoring. This broader perspective is important because prolonged mechanical ventilation can generate multiple interconnected complications, and prevention of one complication may be influenced by interventions targeting another pathway (Martinez-Reviejo et al., 2023; Klompas et al., 2022).

The potential effects on mechanical ventilation duration and ICU length of stay are clinically important because reducing unnecessary ventilator exposure may produce secondary benefits for patients and healthcare systems. A recent study found that greater adherence to VAP prevention bundles was associated with fewer days of mechanical ventilation and shorter length of stay, while also reducing hospital costs. These findings suggest that improving nursing adherence may have implications not only for infection prevention but also for resource utilization and efficiency of critical care services (Al-Harthi et al., 2025).

Variability in Bundle Components

Despite the overall positive direction of evidence, the review also identified considerable variation in the composition of nursing and ventilator bundles. Some bundles emphasized infection prevention measures such as oral care, head-of-bed elevation, and secretion management, whereas others incorporated sedation interruption, SBT, early mobilization, and multidisciplinary interventions. This variation makes direct comparison between studies difficult and may contribute to differences in reported effectiveness (Martinez-Reviejo et al., 2023).

The heterogeneity of bundle composition does not necessarily indicate that one standardized bundle should be applied universally. Instead, the findings suggest that institutions should develop core evidence-based components while allowing adaptation to patient characteristics, local epidemiology, available resources, staffing, and institutional policies. Current recommendations similarly recognize that prevention strategies need to be adapted to the local clinical context while maintaining essential evidence-based practices (Klompas et al., 2022).

Implications for Nursing Practice

The findings have several implications for nursing practice. First, ICU nurses should implement ventilator bundle components as an integrated package rather than as isolated procedures. Second, bundle compliance should be routinely measured using standardized checklists or audit instruments. Third, nursing education should be continuous and competency-based rather than limited to initial training. Fourth, nurses should actively participate in daily assessment of sedation, readiness for spontaneous breathing, airway management, positioning, oral care, and mobilization. Finally, nursing leaders should establish feedback mechanisms that enable frontline nurses to recognize gaps in implementation and improve adherence (Rehmani et al., 2024; Al-Harthi et al., 2025).

For nursing education, the findings provide a basis for strengthening critical care nursing competencies related to mechanical ventilation. Nursing students and practicing nurses should not only learn the technical procedures associated with ventilator care but also understand the physiological rationale behind each bundle component. Competency-based learning that integrates simulation, clinical demonstration, checklist assessment, and outcome monitoring may improve the translation of evidence into clinical practice (Rehmani et al., 2024).

Strengths and Limitations

This systematic review provides a contemporary synthesis of evidence regarding nursing bundle care for adult patients receiving invasive mechanical ventilation and incorporates both clinical outcomes and implementation-related factors. The review also considers the role of nurse compliance, education, and organizational support, which are often overlooked when evaluating the effectiveness of ventilator bundles. However, interpretation of the findings should consider the heterogeneity of study designs, bundle components, patient populations, outcome definitions, and implementation strategies. Differences in methodological quality and the predominance of observational and quasi-experimental studies may also limit causal interpretation. Furthermore, because the synthesis was primarily narrative, quantitative differences between studies could not always be statistically pooled.

CONCLUSION

The conclusion section is this systematic literature review indicates that nursing care bundles are an effective evidence-based approach for improving the quality and safety of care among adult patients receiving invasive mechanical ventilation. Across the reviewed studies, the implementation of multidimensional bundles was generally associated with reduced ventilator-associated pneumonia (VAP), improved ventilator-care practices, and potential reductions in mechanical ventilation duration and intensive care unit length of stay. The most consistently reported components included oral care, head-of-bed elevation, secretion and airway management, sedation optimization, spontaneous awakening and breathing trials, early mobilization, and assessment of readiness for ventilator weaning

The effectiveness of nursing bundle care is strongly influenced by nurse adherence and the quality of implementation. Education, standardized protocols, bedside checklists, regular monitoring, audit and feedback, adequate staffing, and organizational support are important factors in maintaining consistent bundle implementation. Therefore, nursing bundle care should be implemented not merely as a checklist but as a continuous quality-improvement strategy integrated into routine critical care nursing practice.

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