The Review Of
DIABETIC
STUDIES OPEN ACCESS

Impact Of Nursing Interventions On Prevention Of Ventilator-Associated Pneumonia In Intensive Care Units: A Systematic Review

Moamen Abdelfadil Ismail[1], Awad Osman Abdalla Mohamed[2], Nabeel Farhan[3], Osama Mohsen H. Alhazmi[4], Sami Hammad Aljohani[5], Matr Musleh Alsaadi[6], Norah Faisal Othman Alsudani[7], Abdulmonem Hassan Al Qarafi[8], Qassim Sulamin Aljriry[9], Saad Buwayti Almutaire[10], Ghazai Saad Almutairi[11], Mawahib Mohammed Sali Ibrahim[12], Dalya Yousef Hamed[13], Bader Abdullah Saad Ower[14]

[1]Internal Medicine Consultant, King Abdulaziz Specialist Hospital, Sakaka, Aljouf,
[2]MBBS, MD, Department of Anesthesia and Operations, College of Applied Medical Sciences, Khamis Mushait Campus, King Khalid University, Abha 62529, Saudi Arabia
[3]Neurosurgeon and Master of Medical Education, Freiburg International Academy,
[4]Medical Waste, Nursing Technician
[5]Medical waste, Nursing Technician
[6]Nursing, Almeqit Hospital, Inventory Control
[7]Pharmacy Technician, Maternity and Children Hospital
[8]Nursing, Almeqt Hospital, Inventory Control
[9]Healthcare Services Administration, University of Jeddah
[10]Healthcare Services Administration, University of Jeddah
[11]Healthcare Services Administration, University of Jeddah
[12]Medical Sterilization, Faculty of Nursing, Alzaim Alazhari
[13]Nursing, Saudi Council 08JN0029866,
[14] Jeddah University, Medical Administration

Abstract

Background: Ventilator-associated pneumonia (VAP) remains a serious healthcare-associated infection in intensive care units (ICUs), contributing to increased morbidity, mortality, prolonged hospital stays, and elevated healthcare costs. Nurses play a central role in VAP prevention through continuous bedside care and implementation of evidence-based preventive interventions. This systematic review aimed to synthesize evidence on the impact of nursing interventions on VAP prevention among mechanically ventilated adult patients in ICUs.
Methods: A systematic review was conducted following PRISMA guidelines. Electronic searches of PubMed, CINAHL, Scopus, ScienceDirect, and Google Scholar were performed to identify studies published within the last two decades. Studies evaluating nursing-led interventions including oral care protocols, patient positioning, ventilator care bundles, and nurse education programs were included. Two reviewers independently screened articles, extracted data, and assessed methodological quality using appropriate critical appraisal tools. Due to heterogeneity across studies, a narrative synthesis was conducted.
Results: Eight studies met the inclusion criteria, comprising randomized controlled trials, quasi-experimental studies, observational studies, and systematic reviews. Structured oral hygiene interventions consistently reduced VAP incidence, with one study reporting a decrease from 44.6% to 34.3% (OR=0.65) and another demonstrating significant reduction (P=0.015). A meta-analysis reported an odds ratio of 0.61 for antiseptic oral care. Ventilator care bundles reduced VAP rates by over 36% when fully implemented. Nurse compliance with prevention guidelines ranged from 84.6% to 85.9%, with improved adherence following educational interventions. Head-of-bed elevation (≥30°) significantly reduced aspiration risk.
Conclusion: Nursing interventions, including structured oral hygiene protocols, ventilator care bundles, proper patient positioning, and nurse education programs, significantly reduce VAP incidence in ICU settings. Consistent implementation of these evidence-based strategies, supported by ongoing

training and compliance monitoring, is essential for improving patient outcomes, reducing healthcare costs, and enhancing quality of care in mechanically ventilated patients.

Introduction

Background

Ventilator-associated pneumonia (VAP) is one of the most frequent and serious healthcare-associated infections in intensive care units (ICUs). It develops in patients who have been mechanically ventilated for at least 48 hours and is associated with significant morbidity, mortality, prolonged hospital stay, and increased healthcare costs. Despite advances in critical care, VAP remains a persistent challenge worldwide, particularly in settings with limited resources or inconsistent adherence to preventive protocols. Its occurrence reflects the complex interplay between host factors, invasive devices, microbial colonization, and healthcare practices within the ICU environment.

Mechanical ventilation, while lifesaving, bypasses normal upper airway defense mechanisms and facilitates the direct entry of pathogens into the lower respiratory tract. The presence of an endotracheal tube promotes biofilm formation and impairs mucociliary clearance, increasing the risk of aspiration of contaminated secretions. Critically ill patients often have compromised immune responses and underlying comorbidities, further predisposing them to infection. As a result, prevention of VAP has become a central focus in critical care practice and quality improvement initiatives.

Nurses play a pivotal role in the prevention of VAP because they provide continuous bedside care and are directly responsible for many of the interventions included in VAP prevention strategies. Nursing interventions such as maintaining appropriate head-of-bed elevation, performing regular oral hygiene, monitoring cuff pressure, ensuring proper suctioning techniques, and promoting early mobilization are integral components of care bundles aimed at reducing VAP incidence. The effectiveness of these measures depends largely on nurses' knowledge, skills, vigilance, and adherence to established protocols.

The concept of care bundles has gained prominence in efforts to prevent VAP. These bundles consist of a small set of evidence-based practices that, when implemented collectively and consistently, have been shown to improve patient outcomes. Nursing staff are central to implementing and sustaining these bundles, as they coordinate and execute most of the preventive actions. Variability in compliance with bundle components, however, remains a significant barrier to optimal outcomes and underscores the importance of ongoing education and monitoring.

Oral care with antiseptic solutions is one of the most frequently emphasized nursing interventions in VAP prevention. The oral cavity can serve as a reservoir for pathogenic microorganisms, especially in intubated patients who cannot perform self-care. Structured oral hygiene protocols help reduce bacterial colonization and subsequent aspiration into the lower respiratory tract. Consistency in technique and frequency of oral care is essential to maximize its preventive benefits.

Positioning strategies, particularly maintaining the head of the bed at an elevation of 30 to 45 degrees, are simple yet highly effective nursing measures to reduce the risk of aspiration. Proper patient positioning minimizes the reflux of gastric contents and oropharyngeal secretions into the lungs. Nurses are responsible for assessing patient tolerance to positioning, documenting compliance, and addressing contraindications, making their role crucial in ensuring the effectiveness of this intervention.

Suctioning and airway management practices also significantly influence VAP risk. Appropriate handling of ventilator circuits, minimizing circuit disconnections, and using aseptic techniques during suctioning help prevent contamination. Nurses must balance the need for secretion clearance with the potential for introducing pathogens. Continuous education and competency assessment are necessary to maintain high standards of infection control practices in these procedures.

Sedation management and daily assessment of readiness for extubation are additional areas where nursing input is vital. Excessive sedation may prolong mechanical ventilation, thereby increasing the duration of exposure to VAP risk factors. Nurses collaborate with physicians to implement sedation protocols and monitor patients' neurological status, contributing to earlier weaning from ventilation when clinically appropriate. Reduced duration of ventilation is directly associated with decreased VAP incidence.

The burden of VAP extends beyond clinical outcomes to include economic and organizational consequences. Increased length of ICU stay, additional diagnostic procedures, and prolonged antibiotic

therapy contribute to higher healthcare costs. Preventive nursing interventions, when effectively implemented, offer a cost-effective strategy to improve patient safety and reduce resource utilization. Consequently, understanding the impact of nursing-driven strategies is critical for healthcare administrators and policymakers.

Given the central role of nurses in delivering preventive care, evaluating the impact of nursing interventions on VAP prevention is essential. A systematic review of existing evidence can provide a comprehensive synthesis of the effectiveness of these interventions, identify gaps in current practice, and inform future research and policy development. By critically analyzing available studies, such a review can strengthen evidence-based nursing practice and contribute to improved outcomes for mechanically ventilated patients in intensive care settings.

Methodology

Study Design and Framework

The present research was conducted as a systematic review designed to synthesize evidence on nursing interventions aimed at preventing ventilator-associated pneumonia (VAP) among mechanically ventilated patients. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparent and replicable reporting of search strategy, selection criteria, data extraction, and synthesis. Studies of various designs were considered provided they evaluated nursing or nurse-implemented preventive strategies and reported VAP-related outcomes.

Eligibility Criteria

Studies were eligible if they: (1) involved adult patients undergoing mechanical ventilation, (2) described nursing-led interventions (e.g., oral care, positioning, head-of-bed elevation, education programs), (3) reported incidence of VAP or related outcomes, and (4) were published in English within the last two decades. Both randomized controlled trials (RCTs), observational studies, and systematic reviews were included to capture a wide range of evidence. Reviews that did not focus on nursing interventions were excluded.

Search Strategy and Databases

An electronic search of major medical and nursing databases, including PubMed, CINAHL, Scopus, ScienceDirect, and Google Scholar, was undertaken. Search terms combined key concepts such as “ventilator-associated pneumonia,” “nursing interventions,” “oral care,” “positioning,” “mechanical ventilation,” and “prevention”. Additional manual searches were performed on reference lists of included articles. The final search included publications up to 2025 to ensure recent evidence was captured.

Study Selection and Screening Process

Two reviewers independently screened articles in two phases: first by titles and abstracts, and then through full-text reviews. Discrepancies were resolved through consensus or consultation with a third reviewer. Eligibility was confirmed based on predefined inclusion criteria. A total of 8 studies were ultimately included in the final synthesis, encompassing RCTs, cohort studies, and systematic reviews where nursing interventions were evaluated for VAP prevention.

Data Extraction

Data were extracted using a structured form that captured study characteristics (authors, year, design), intervention types, comparison conditions, outcome measures (e.g., VAP incidence, length of ICU stay), and key findings. Instances of educational, procedural, and care bundle interventions were identified and tabulated. For RCTs of oral care and positioning, extraction included details on frequency, technique, and outcomes related to VAP incidence.

Quality Assessment

The methodological quality of primary studies was appraised using appropriate tools. Randomized controlled trials were evaluated using the Joanna Briggs Institute (JBI) critical appraisal checklists due to its suitability for clinical intervention studies. For observational studies, bias risk was assessed via

relevant quality scales. Systematic reviews were appraised for rigour of search strategy, inclusion criteria, and synthesis method. Low-quality studies were not excluded but their limitations were carefully noted during synthesis.

Intervention Categories
Nursing interventions were grouped into core categories: oral care protocols, patient positioning and head-of-bed elevation, education and compliance strategies, and multicomponent care bundles. Oral care ranged from standardized teeth brushing to antiseptic use, while positioning emphasized semirecumbent postures to reduce aspiration risk. Education programmes targeted nurse knowledge and adherence, and care bundles combined multiple practices into coordinated protocols.

Data Synthesis and Outcomes
Due to heterogeneity in study designs and outcome reporting, a narrative synthesis was conducted. VAP incidence was the primary outcome of interest; secondary outcomes included ICU length of stay, duration of mechanical ventilation, and nurse compliance with prevention protocols. Evidence from systematic reviews and meta-analyses was used to contextualize findings from individual trials and observational studies.

Analytical Approach
Statistical pooling was not undertaken because of variability across populations, interventions, and outcome measures. Instead, studies demonstrating consistent reductions in VAP incidence with nursing interventions were highlighted. For example, care bundle implementation generally showed significant decreases in VAP rates in adult ICU populations, with some studies reporting reductions above 36 % and even over 65 % when fully implemented (Mastrogianni et al., 2023).

Ethical Considerations
As this research involved synthesis of previously published studies and did not involve human subjects or identifiable patient data, ethical approval was not required. The study adhered to ethical standards for systematic reviews by accurately reporting and citing all included sources.

Limitations of Methodology
The review acknowledged limitations inherent in the available literature, including varied definitions of VAP, inconsistent reporting of intervention fidelity, and potential publication bias. Heterogeneity across studies limited direct comparison and aggregation of results. Additionally, some older studies lacked rigorous design or standardized outcome measures.

Results
A total of 8 studies that evaluated nursing-implemented interventions to prevent ventilator-associated pneumonia (VAP) in adult intensive care unit (ICU) patients were included in the final analysis. These studies examined several nursing strategies including oral care protocols, ventilator care bundles, patient positioning, and nurse compliance with prevention guidelines. Most studies investigated the effect of structured nursing interventions on VAP incidence, patient outcomes, and adherence to prevention protocols.

Table 1: Oral Care Interventions and Their Effects on VAP Incidence

Study	Design	Intervention Description	VAP Outcome	Statistical Result
Sabrah et al., 2024	Quasi-experimental	Oral care bundle compared with routine oral care	Lower VAP incidence in intervention group	Significant reduction (P = 0.015)
Oikawa et al., 2025	Systematic review and meta-analysis	Antiseptic oral hygiene interventions including chlorhexidine	Reduced VAP risk in several interventions	OR = 0.61

Saito et al., 2022	Prospective interventional study	Regular physical oral care using sponge brushing	Reduction in VAP incidence	VAP decreased from 44.6% to 34.3%, OR = 0.65
Lei et al., 2023	Randomized controlled trial	Comprehensive oral nursing intervention compared with routine care	Reduced VAP and improved patient outcomes	Significant reduction ($P < 0.05$)

Studies evaluating oral hygiene interventions consistently demonstrated a reduction in ventilator-associated pneumonia rates. In the quasi-experimental study by Sabrah et al. (2024), implementation of an oral care bundle significantly reduced VAP incidence compared with routine care ($P = 0.015$).
Similarly, the meta-analysis conducted by Oikawa et al. (2025) found that antiseptic oral care interventions, particularly chlorhexidine use, reduced VAP risk with an odds ratio of 0.61, indicating a meaningful preventive effect.
A prospective interventional study by Saito et al. (2022) reported that implementing structured physical oral care significantly decreased VAP incidence from 44.6% to 34.3%, corresponding to an odds ratio of 0.65.
In addition, the randomized controlled trial conducted by Lei et al. (2023) demonstrated that a comprehensive oral nursing intervention significantly lowered VAP occurrence and improved clinical outcomes compared with routine nursing care ($P < 0.05$).
These findings collectively indicate that structured oral hygiene protocols delivered by nurses are a critical component of VAP prevention strategies in ICUs.

Table 2: Ventilator Care Bundles and Nurse Compliance

Study	**Design**	**Intervention**	**Nurse Compliance / Outcome**	**Key Findings**
Abad et al., 2021	Cross-sectional study	Assessment of VAP bundle knowledge and implementation	Median compliance 84.6%	Higher knowledge associated with improved bundle implementation
Akhter et al., 2025	Interventional study	Evidence-based VAP prevention bundle implementation	High adherence after intervention	Improved adherence to bundle practices
Al-Sayaghi, 2021	Cross-sectional survey	Assessment of nurses' compliance with VAP prevention guidelines	Mean compliance 85.9%	Lower compliance for some procedures such as subglottic suctioning

Several studies examined nurses' compliance with ventilator care bundles and prevention guidelines. The cross-sectional study by Abad et al. (2021) reported a median compliance level of 84.6% among ICU nurses implementing VAP prevention bundles, suggesting generally high adherence to evidence-based practices.
Similarly, Al-Sayaghi (2021) reported a mean compliance level of 85.9%, although some components such as subglottic suctioning demonstrated lower adherence rates.
An interventional study conducted by Akhter et al. (2025) demonstrated that implementation of an evidence-based VAP prevention bundle improved adherence to recommended practices, including head-of-bed elevation, oral hygiene, and proper airway management.
These findings suggest that nursing education and training programs significantly enhance adherence to VAP prevention strategies, which may ultimately reduce infection rates in ICU settings.

Table 3: Patient Positioning and VAP Prevention

Study	Design	Intervention	Impact on VAP Prevention	Key Findings
Kaş Güner & Kutlutürkan, 2022	Randomized controlled trial	Head-of-bed elevation (≥30°) compared with lower elevation	Reduced aspiration risk	Supports semirecumbent positioning as VAP prevention strategy

Patient positioning represents one of the simplest yet most effective nursing interventions for preventing ventilator-associated pneumonia. The randomized controlled trial conducted by Kaş Güner and Kutlutürkan (2022) evaluated the effect of head-of-bed elevation of 30° or greater compared with lower elevations.

The findings demonstrated that maintaining patients in a semirecumbent position significantly reduced the risk of aspiration, which is a major contributing factor to VAP development.

These results support the inclusion of head-of-bed elevation as a standard component of ventilator care bundles, emphasizing the important role nurses play in ensuring consistent implementation of this preventive measure.

Discussion

Ventilator-associated pneumonia (VAP) remains one of the most significant complications among mechanically ventilated patients in intensive care units. The present systematic review examined the impact of nursing interventions on preventing VAP and highlighted several strategies including oral hygiene protocols, ventilator care bundles, nurse compliance with prevention guidelines, and patient positioning. The findings of this review demonstrate that structured nursing interventions significantly contribute to reducing VAP incidence and improving patient outcomes in intensive care settings.

One of the most important findings of this review was the effectiveness of oral care interventions in reducing VAP rates. Several included studies demonstrated that implementing structured oral hygiene protocols significantly lowered infection rates among mechanically ventilated patients. For instance, Sabrah et al. (2024) reported that implementing an oral care bundle significantly reduced VAP incidence compared with routine oral care practices. These findings support the notion that oral hygiene plays a critical role in preventing bacterial colonization in the oropharyngeal region, which is a major source of pathogens responsible for ventilator-associated pneumonia.

Similarly, the prospective interventional study conducted by Saito et al. (2022) demonstrated that physical oral care interventions led to a notable decrease in VAP incidence, with infection rates declining from 44.6% to 34.3%. This significant reduction highlights the effectiveness of regular oral hygiene procedures performed by trained nursing staff. By minimizing bacterial colonization in the oral cavity, nurses can substantially reduce the risk of aspiration of pathogenic microorganisms into the lower respiratory tract.

The randomized controlled trial conducted by Lei et al. (2023) further confirmed the positive impact of comprehensive oral nursing interventions. Their study found that patients who received enhanced oral care experienced significantly lower rates of ventilator-associated pneumonia compared with those who received routine care. This evidence strengthens the argument that integrating comprehensive oral care protocols into routine nursing practice is essential for preventing VAP in ICU settings.

In addition to individual oral care interventions, systematic reviews and meta-analyses have also supported the effectiveness of oral hygiene measures. Oikawa et al. (2025) reported that antiseptic oral care, particularly the use of chlorhexidine, was associated with a reduced risk of VAP with an odds ratio of 0.61. These findings align with the results of the present review, indicating that oral antiseptics can serve as an effective preventive measure when incorporated into routine nursing practice for mechanically ventilated patients.

Another important aspect highlighted by this review is the effectiveness of ventilator care bundles. Care bundles combine multiple evidence-based interventions, such as head-of-bed elevation, oral hygiene, sedation management, and suctioning protocols, to improve patient outcomes. Previous research has demonstrated that implementing such bundles significantly reduces VAP rates. For example, the

systematic review conducted by Mastrogianni et al. (2023) reported that the implementation of ventilator care bundles reduced VAP incidence by more than 36% in many ICU settings.

Furthermore, education and training programs play a vital role in ensuring successful implementation of VAP prevention strategies. The cross-sectional study conducted by Abad et al. (2021) reported that ICU nurses demonstrated a high level of compliance with VAP prevention bundles, with median adherence levels reaching approximately 84.6%. This finding suggests that increased awareness and knowledge among nursing staff are key factors in improving adherence to infection prevention protocols.

Similarly, the survey conducted by Al-Sayaghi (2021) found that the overall compliance of critical care nurses with VAP prevention guidelines reached an average of 85.9%. However, the study also identified certain areas with lower adherence, such as subglottic suctioning procedures. These results indicate that although nurses generally follow preventive guidelines, targeted training programs may be required to improve adherence to specific components of VAP prevention strategies.

Another study included in this review by Akhter et al. (2025) demonstrated that the implementation of evidence-based VAP prevention practices significantly improved compliance with recommended interventions. Their findings suggest that structured training and guideline implementation can enhance the consistency of preventive practices among ICU nurses. Improved adherence to these protocols is likely to contribute to better infection control outcomes and lower VAP rates.

Patient positioning was also identified as an important nursing intervention in preventing ventilator-associated pneumonia. Maintaining patients in a semirecumbent position has been widely recommended as a preventive measure against aspiration of gastric contents. The randomized controlled trial conducted by Kaş Güner and Kutlutürkan (2022) demonstrated that elevating the head of the bed to at least 30 degrees significantly reduced the risk of aspiration and subsequently decreased the likelihood of VAP development.

The effectiveness of head-of-bed elevation is largely attributed to its ability to minimize gastroesophageal reflux and aspiration of contaminated secretions. Since aspiration is a major pathway through which pathogens enter the lower respiratory tract, proper patient positioning becomes a simple yet highly effective preventive intervention. Nurses play a central role in maintaining appropriate patient positioning and ensuring consistent adherence to this practice.

The results of this review also emphasize the critical role of nurses in infection prevention within intensive care units. Nurses provide continuous bedside care and are directly responsible for implementing most VAP prevention strategies. Their close monitoring of patients, adherence to infection control protocols, and timely implementation of preventive measures contribute significantly to reducing healthcare-associated infections.

Another important observation from this review is that the effectiveness of VAP prevention strategies often depends on the integration of multiple interventions rather than a single measure. Combining oral care, patient positioning, ventilator care bundles, and staff education can produce synergistic effects in reducing infection rates. This approach supports the use of comprehensive care bundles as a standard practice in modern critical care settings.

Despite the positive findings observed in this review, certain limitations must be acknowledged. The included studies varied in design, intervention protocols, and outcome measurements, which may have influenced the comparability of results. Additionally, some studies relied on observational or cross-sectional designs, which may limit the ability to establish causal relationships between interventions and outcomes.

Another limitation relates to differences in ICU settings and patient populations across studies. Variations in staffing levels, training programs, and available resources may affect the implementation of nursing interventions. Consequently, the effectiveness of certain strategies may differ across healthcare institutions. Future research should aim to conduct large-scale randomized controlled trials to further evaluate the impact of nursing interventions on VAP prevention.

Overall, the findings of this systematic review reinforce the importance of evidence-based nursing interventions in preventing ventilator-associated pneumonia. Oral hygiene protocols, ventilator care bundles, patient positioning, and nurse education programs all contribute significantly to reducing infection rates among mechanically ventilated patients. Implementing these strategies consistently across ICU settings can improve patient safety and enhance the quality of critical care services.

Conclusion

This systematic review demonstrated that nursing interventions play a crucial role in the prevention of ventilator-associated pneumonia in intensive care units. Evidence from the included studies indicates that structured oral hygiene protocols, ventilator care bundles, head-of-bed elevation, and improved nurse compliance with prevention guidelines significantly reduce VAP incidence among mechanically ventilated patients. The findings highlight the importance of continuous nursing education, adherence to evidence-based practices, and the implementation of comprehensive care bundles to improve infection control outcomes. Strengthening these nursing interventions can contribute to better patient outcomes, reduced healthcare costs, and improved quality of care in critical care settings.

References

1. Mastrogianni, M., Katsoulas, T., Galanis, P., Korompeli, A., & Myrianthefs, P. (2023). The Impact of Care Bundles on Ventilator-Associated Pneumonia (VAP) Prevention in Adult ICUs: A Systematic Review. Antibiotics (Basel, Switzerland), 12(2), 227. https://doi.org/10.3390/antibiotics12020227
2. Sabrah NYA, Pellegrino JL, Mansour HE-S, Mostafa MF, Kandeel NA. Care Bundle Approach for Oral Health Maintenance and Reduction of Ventilator-Associated Pneumonia. Crit Care Nurs Q. 2024. https://pubmed.ncbi.nlm.nih.gov/39265114/
3. Oikawa H, Nozaki S, Furuichi M, et al. Oral hygiene care for critically ill children to prevent ventilator-associated pneumonia: systematic review and meta-analysis. J Hosp Infect. 2025. https://pubmed.ncbi.nlm.nih.gov/40441360/
4. Saito, S., Thao, P. T. N., Ishikane, M., Xuan, P. T., Kutsuna, S., Dai, H. Q., Ohtsu, H., Kimura, T., Kiyohara, H., Shimada, Y., Maruoka, Y., Thuy, P. T. P., Phu, T. T., Phuong, H. K., Tra, T. T., Duy, N. L. M., Ohara, H., Kurosu, H., Son, N. T., & Ohmagari, N. (2022). Physical oral care prevents ventilator-associated pneumonia in Vietnam: A prospective interventional study. Journal of infection and chemotherapy : official journal of the Japan Society of Chemotherapy, 28(12), 1632–1638. https://doi.org/10.1016/j.jiac.2022.08.017
5. Lei, S., Liu, Y., Zhang, E. et al. Influence of oral comprehensive nursing intervention on mechanically ventilated patients in ICU: a randimized controlled study. BMC Nurs 22, 293 (2023). https://doi.org/10.1186/s12912-023-01464-w
6. Abad CL, Formalejo CP, Mantaring DLM. Assessment of knowledge and implementation practices of the VAP bundle in ICU. Antimicrob Resist Infect Control. 2021. https://aricjournal.biomedcentral.com/articles/10.1186/s13756-021-01027-1
7. Akhter, N., Zhou, X., Elhabashy, S., M. Ehsanul Huq, A. T., Rahman, M. M., & Moriyama, M. (2025). Evidence-Based Practices to Prevent Ventilator-Associated Pneumonia in an Intensive Care Unit in Bangladesh. Healthcare, 13(21). https://doi.org/10.3390/healthcare13212782
8. Kaş Güner C, Kutlutürkan S. Role of head-of-bed elevation in preventing VAP. Nurs Crit Care. 2022. https://pubmed.ncbi.nlm.nih.gov/33884691/
9. Al-Sayaghi, K. M. (2021). Critical care nurses' compliance and barriers toward ventilator-associated pneumonia prevention guidelines: Cross-sectional survey. Journal of Taibah University Medical Sciences, 16(2), 274-282. https://doi.org/10.1016/j.jtumed.2020.12.001