Efficacy of A Ventilation Care Bundle to Prevent Ventilator-Associated Pneumonia: A Literature Review

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1. Introduction

Ventilator-associated pneumonia (VAP) is a condition characterized by the development of pneumonia in patients who are receiving mechanical ventilation, often occurring 48–72 hours after the insertion of an endotracheal tube. The fundamental premise for preventing ventilator-associated pneumonia is to minimize the length of time a patient is on mechanical ventilation and to extubate them as early as possible. Adhering to the bundle of care can influence the risk of VAP. Researchers conducted several studies between 2020 and 2023 to assess the effectiveness of a ventilation care bundle in preventing ventilator-associated pneumonia. Each study varied in terms of the specific version of the care bundle used, compliance rates, sample size, and duration of the research. The conclusion drawn on the effectiveness in question may be impacted by these disparities. Proper execution of an effective ventilator care package can decrease the occurrence of ventilator-associated pneumonia in patients who are critically ill. Employing a variety of tactics backed by long-term teaching initiatives is crucial to ensure adherence to the care bundle.

Ventilator-assOCIated pneumonia (VAP) is a kind of pneumonia that arises within 48–72 hours or later after the insertion of a breathing tube into the windpipe. The fundamental idea of preventing ventilator-associated pneumonia is to minimize the length of time a patient is on mechanical ventilation and to extubate them as early as possible. Adhering to the bundle of care can influence the risk of VAP. Researchers conducted several studies between 2020 and 2023 to assess the effectiveness of a ventilation care bundle in preventing ventilator-associated pneumonia. Each study varied in terms of the specific version of the care bundle used, compliance rates, sample size, and duration of the research. The conclusion drawn on the effectiveness in question may be impacted by these disparities. Proper execution of an effective ventilator care package can decrease the occurrence of ventilator-associated pneumonia in patients who are critically ill. Employing a variety of tactics backed by long-term teaching initiatives is crucial to ensure adherence to the care bundle.

Patients who require mechanical ventilation for a duration beyond 24 hours face a significantly increased risk, ranging from 6 to 21 times, of developing ventilator-associated pneumonia (VAP). Studies have demonstrated that using VAP bundles effectively decreases the incidence of VAP and has become the universally accepted approach for managing patients on mechanical ventilation. Previous research indicates that the proper use of VAP bundles can result in a 13.30 per 1,000 ventilator days reduction in VAP rates. The prior study examined the correlation between adherence to ventilator bundle protocols and the occurrence of ventilator-associated pneumonia (VAP). The findings indicated that proper ventilator bundle care reduced the incidence of VAP.
Ventilator-associated pneumonia (VAP)

Ventilator-associated pneumonia refers to a lung infection that occurs after a patient has been on mechanical ventilation for more than two consecutive days, starting from the day of ventilator insertion or the day before. Ventilator-associated pneumonia (VAP) refers to pneumonia that develops within 48–72 hours after endotracheal intubation. It’s known when there are signs of a systemic infection, a new or worsening infiltrate on imaging, changes in the characteristics of the sputum, and the identification of the pathogen that caused it.²

Ventilator-associated pneumonia is a prevalent illness among critically ill patients who rely on mechanical ventilators. Ventilator-associated pneumonia contributes to higher patient morbidity and death rates, prolonged hospital stays, and increased economic and psychological burdens on patients and their families.⁵

Intensive Care Units (ICUs) may have very different rules for diagnosing ventilator-associated pneumonia (VAP), but most of the time, they include signs of an infection, like a rise in white blood cells (leukocytosis) or fever, a positive culture of respiratory secretions, progressive infiltration on a chest X-ray, and less gas exchange and desaturation.⁶ Germs introduced into the lower respiratory tract can cause ventilator-associated pneumonia in intubated patients with an endotracheal tube. Possible sites of inoculation include the oropharynx, subglottic region, sinuses, and gastrointestinal tract. The goal of interventions is to lower the risk of repeated microaspiration, the growth of harmful organisms in the upper airway and digestive system, and the contamination of the ventilator.⁷

VAP presents itself in two forms: either by colonizing the respiratory and gastrointestinal systems or by the microaspiration of secretions from the upper and lower airways. Aspiration is the predominant possible etiology of VAP. Mechanical ventilation links this iatrogenic illness to prolonged hospitalization and the need for the administration of broad-spectrum antibiotics.⁸

Bundle of care for ventilation

An all-encompassing strategy for preventing ventilator-associated pneumonia (VAP) involves addressing mechanical, functional, and pharmaceutical factors. The primary measure to prevent ventilator-associated pneumonia (VAP) is to refrain from intubation. If feasible, the alternative options consist of noninvasive positive pressure ventilation. Previous research has shown that healthcare providers should carefully administer sedatives, maintain oral and hand hygiene, position patients semi-upright, utilize subglottic suction, control cuff pressure, and prevent deep vein thrombosis for patients who need to be intubated.⁶

Ventilator bundles are established methods based on research that might lead to different outcomes in terms of quality. Different types of care may include basic things like putting the patient in a semi-recumbent position, brushing and flossing their teeth regularly, not using nasogastric tubes, and finding ways to shorten the time they need an endotracheal tube (ETT) or mechanical ventilation by limiting sedation and testing their ability to breathe on their own.⁹

Potential techniques to decrease sedation include giving tailored mild sedation and regular sedative pauses for patients without contraindications. An analysis of six randomized studies revealed that implementing strategies to reduce sedation resulted in a significantly reduced duration of stay in the intensive care unit (ICU) compared to managing patients without such protocols. There was no significant connection between the application of strategies to decrease sedation and the length of mechanical breathing or short-term mortality.¹⁰

One element of the ventilation care bundle is administering enteral feeding at an early stage instead of relying on parenteral nutrition. Administering nutrition through the gastrointestinal tract early on reduces the likelihood of developing pneumonia and shortens hospitalization compared to delayed administration through the gastrointestinal tract or early administration through intravenous means.¹⁰

Including subglottic suction as a component of the
VAP bundle benefits patients who have been ventilated for more than 72 hours. Patients intubated through the trachea must maintain a cuff pressure of 20–30 cm (with an ideal value of 25 cmH2O) and undergo cuff pressure measurement at least every 4–6 hours. Replace ventilator tubing and suction systems only when there is a specific indication of contamination.²

Triamvisit et al. reported that the occurrence of ventilator-associated pneumonia (VAP) in critical care units varies between 7.7 and 27.8 cases per 1,000 days of ventilator usage. People who have endotracheal tubes often have a lot of normal or abnormal secretions build up above the ETT cuff. This is because leftover stomach contents can reflux, and the person doesn’t have a normal cough mechanism to protect them. Pathogenic microorganisms will gather and proliferate in these bodily fluids, and the inhalation of these fluids into the respiratory tract is a major factor contributing to the development of ventilator-associated pneumonia (VAP).³

Patients in the supine posture are also at risk for ventilator-associated pneumonia. Studies have demonstrated that increasing the angle of the bed to 45 degrees decreases the incidence of ventilator-associated pneumonia (VAP). The precise threshold of altitude necessary to avoid ventilator-associated pneumonia (VAP) remains uncertain. Research suggests that maintaining a minimum 30-degree elevation of the bed and refraining from lying flat on the back will effectively decrease the likelihood of developing ventilator-associated pneumonia (VAP).⁷

Raising the head of the bed in a meta-analysis of 8 randomized trials was associated with a significant decrease in the incidence of ventilator-associated pneumonia (VAP), but did not show any significant differences in the length of mechanical ventilation or death. However, there is a limited amount of evidence available on outcomes other than ventilator-associated pneumonia (VAP).¹⁰

Currently, healthcare providers can employ advanced therapeutic concepts to prevent ventilator-associated pneumonia (VAP), thereby improving outcomes for patients requiring mechanical ventilation. Most hospitals have efficiently implemented ventilator bundle therapy choices, but the optimal mix of therapies remains uncertain.¹¹

The effectiveness of a ventilation care package

From 2020 to 2023, researchers conducted multiple studies to assess the effectiveness of a ventilation care bundle in preventing ventilator-associated pneumonia. Each study utilized a different version of the care bundle, assessed compliance, had varying sample sizes, and lasted for varied durations. The conclusion drawn on the effectiveness in question may be influenced by these disparities. Proposals have been made to adopt “bundles” of successful approaches as opposed to individual interventions in order to decrease the occurrence of catheter-related bloodstream infections.¹²

Martinez-Reviejo et al. conducted a study comparing patient outcomes between a group receiving care bundles and a group receiving normal treatment (non-care bundles). The study included a total of 84,031 participants who received care bundles for the prevention of ventilator-associated pneumonia (VAP). The study found that the deployment of ventilator care bundles resulted in a decrease in the occurrence of ventilator-associated pneumonia (VAP) episodes and the length of time patients required mechanical ventilation (MV) in adult intensive care units (ICUs). Their utilization, in conjunction with educational initiatives, seems to enhance clinical results.¹

Liu et al. found that strict adherence to all intervention measures for the ventilator care bundle resulted in better results in the intervention group compared to the control group. Furthermore, there was a significant rise in the rate of hand hygiene compliance, rising from 71.99% to 91.97%. Similarly, the percentage of patients with a head of bed height between 30° and 45° went from 62.02% to 85.96%. The statistical analysis revealed substantial disparities between the two groups in all aspects.¹³

While the use of an effective ventilator care bundle can decrease the occurrence of ventilator-associated pneumonia (VAP), Raghavi et al. discovered that although the overall compliance with the VAP bundle was high at 89.6%, compliance with specific
components, including oral hygiene, subglottic suctioning, and hand hygiene, was not ideal.¹⁴

Triamvisit et al. demonstrated that a modified VAP bundle, consisting of more frequent intermittent ET cuff pressure monitoring (every 4 hours, six times a day) and less frequent oral care (every 8 hours, three times a day), is equally or even more effective in reducing the occurrence of VAP compared to our previous VAP bundle (0.88/1,000 vs. 6.84/1,000 ventilator days, P = 0.036). The length of stay was also shortened, but it did not exhibit statistical significance (11.88 vs. 15.42 days, P = 0.217).

A meta-analysis showed that taking a 0.12% chlorhexidine solution by mouth is the best way to avoid ventilator-associated pneumonia (VAP), taking into account things like cost, side effects, and medication resistance.³ In a multicenter research setting, Bashar et al. conducted a randomized, controlled, triple-blinded clinical trial in 2021 to assess the impact of 17-ventilator care bundles and various training methodologies for critical care nurses on clinical outcomes. The study examined clinical outcomes across four groups, consisting of three intervention groups (who got 17-ventilator care packages administered by skilled nurses) and one control group (who received standard care). The results indicate that the control group had substantially higher values for ICU length of stay, non-ICU length of stay, ventilator-associated pneumonia incidence date, ventilator-associated pneumonia, and fatality rates compared to the other groups.¹⁵

In line with previous findings, Santos conducted a study in 2021 on the effectiveness of a prevention bundle for ventilator-associated pneumonia (VAP) in an adult intensive care unit. The study revealed that the incidence of VAP prior to the implementation of the bundle (2011–2013) was 31.1%, 29.8%, and 36.6%, respectively. The post-implementation period saw a notable increase, with the recorded incidence reaching 17.6% in 2016.¹⁶

In line with a prior investigation, Abad et al. evaluated "the level of understanding and application of the ventilator-acquired pneumonia (VAP) bundle in the intensive care unit of a private hospital." Both intensivist critical care physicians (ICPs) and nurses had knowledge regarding the ventilator-associated pneumonia (VAP) bundle, as indicated by the study. Adherence to the entire bundle is limited, and there is still a lack of understanding of the essential elements of VAP preventive recommendations. The research recommended frequent implementation of formal training and interactive educational sessions to evaluate the proficiency of key workers in relation to the VAP bundle.¹⁷

In 2023, Paliwal et al. assessed "knowledge, barriers to implementation, and compliance with the ventilator bundle among resident doctors and nurses working in intensive care units of a tertiary care center in Western India with a cross-sectional survey, where all registered nurses and resident doctors who are direct care providers to patients in the ICU were included. Paliwal et al. administered two sets of questions to assess knowledge and identify potential obstacles in the implementation of VB."¹⁸

2. **Conclusion**

Proper execution of an effective ventilator care package can decrease the occurrence of ventilator-associated pneumonia in patients who are critically ill. Employing a range of tactics bolstered by comprehensive, ongoing educational initiatives is imperative to maintain compliance with the care bundle.

3. **References**


