

## PREVENTION OF VENTILATOR-ASSOCIATED COMPLICATIONS IN PULMONARY AND AIRWAY SURGERY

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*Ventilator-associated complications remain a significant concern in pulmonary and airway surgery, contributing to increased morbidity, prolonged hospital stay, and higher healthcare costs. Effective prevention strategies are essential to improve patient outcomes and reduce postoperative complications. This article reviews the current approaches to preventing VACs, including proper ventilator management, aseptic techniques, perioperative antibiotic prophylaxis, patient positioning, and early mobilization. Emphasis is placed on evidence-based protocols and multidisciplinary strategies that minimize infection risk, improve pulmonary function, and enhance overall postoperative recovery. Implementation of these preventive measures can significantly reduce the incidence of ventilator-associated pneumonia and other related complications, leading to better*

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*clinical outcomes and improved patient safety.*

**Introduction:** Ventilator-associated complications (VACs) represent a major challenge in modern pulmonary and airway surgery. These complications, which include ventilator-associated pneumonia (VAP), barotrauma, volutrauma, and atelectasis, are associated with increased postoperative morbidity, prolonged hospital stay, higher treatment costs, and, in severe cases, increased mortality. Patients undergoing pulmonary or airway surgery are particularly susceptible to VACs due to pre-existing respiratory conditions, impaired lung function, prolonged anesthesia, and the invasiveness of the surgical procedure. The incidence of ventilator-associated pneumonia remains one of the most significant concerns in thoracic and airway surgery. VAP can develop as a result of bacterial colonization of the endotracheal tube, impaired mucociliary clearance, aspiration, and immune system compromise. In addition, mechanical ventilation itself can induce lung injury, impair pulmonary mechanics, and alter alveolar-capillary gas exchange. These pathophysiological changes underscore the critical need for effective preventive strategies to reduce the burden of VACs. Recent advances in perioperative care emphasize the importance of a multidisciplinary approach to prevention. Proper ventilator management, strict adherence to aseptic techniques, careful patient positioning, perioperative antibiotic prophylaxis, oral hygiene, and early mobilization are all evidence-based interventions that significantly reduce the risk of VACs. Furthermore, continuous monitoring of respiratory parameters and early recognition of subtle signs of infection are crucial for timely intervention and minimizing complications. Despite significant progress in surgical techniques and intensive care management, VACs continue to pose a threat to patient safety and recovery. This highlights the need for ongoing research and implementation of standardized preventive protocols. By focusing on comprehensive, evidence-based strategies, healthcare professionals can minimize the occurrence of ventilator-associated complications, improve pulmonary function postoperatively, and enhance overall surgical outcomes.

**Methods:** This study was conducted on patients undergoing pulmonary and airway surgical procedures in a tertiary care hospital over a period of 12 months. The study included adult patients aged 18 years and older who required perioperative mechanical ventilation for thoracic or airway surgery. Patients with pre-existing severe pulmonary

infections, immunodeficiency, or recent thoracic surgery within the last six months were excluded to reduce confounding factors. The primary focus of the study was the implementation and evaluation of comprehensive preventive strategies aimed at reducing ventilator-associated complications (VACs), including ventilator-associated pneumonia (VAP), barotrauma, and atelectasis. Patients were divided into two groups: the intervention group, which received a structured preventive care bundle, and the control group, which received standard perioperative care. The preventive care bundle included evidence-based interventions such as:

1. **Proper ventilator management:** Optimizing tidal volume, positive end-expiratory pressure (PEEP), and respiratory rate to minimize ventilator-induced lung injury.
2. **Aseptic techniques:** Strict adherence to sterile procedures during intubation, suctioning, and handling of the ventilator circuit.
3. **Perioperative antibiotic prophylaxis:** Administration of antibiotics according to institutional guidelines based on surgical risk and patient comorbidities.
4. **Patient positioning:** Elevation of the head of the bed to 30–45 degrees to reduce aspiration risk and promote lung expansion.
5. **Oral hygiene and suctioning:** Regular oral care and removal of secretions to minimize bacterial colonization of the airway.
6. **Early mobilization and physiotherapy:** Initiation of postoperative respiratory physiotherapy and mobilization as early as clinically feasible to enhance lung function and prevent atelectasis.

Data collection included demographic characteristics, preoperative pulmonary function, duration of mechanical ventilation, and incidence of VACs. Patients were monitored closely for signs of infection, oxygenation parameters, ventilatory settings, and postoperative outcomes. Laboratory and microbiological data were recorded to confirm any episodes of VAP or other ventilator-associated infections. Statistical analysis was performed using descriptive and inferential methods. Continuous variables were expressed as mean  $\pm$  standard deviation, and comparisons between groups were performed using Student's t-test or non-parametric equivalents when appropriate. Categorical variables were analyzed using chi-square or Fisher's exact test. A p-value of less than 0.05 was considered statistically significant. This methodological approach allowed for a comprehensive evaluation of preventive strategies for ventilator-associated complications and provided insights into the

effectiveness of evidence-based interventions in improving postoperative pulmonary outcomes and patient safety.

**Results:** During the 12-month study period, a total of 120 patients undergoing pulmonary and airway surgery were included, with 60 patients in the intervention group and 60 in the control group. Baseline characteristics, including age, gender distribution, preoperative pulmonary function, and comorbidities, were similar between the two groups, ensuring comparability for outcome analysis. The incidence of ventilator-associated complications (VACs) was significantly lower in the intervention group compared to the control group. Specifically, ventilator-associated pneumonia (VAP) occurred in 5% of patients in the intervention group, versus 18% in the control group ( $p < 0.01$ ). Other complications, including barotrauma and atelectasis, were also reduced in the intervention group, with barotrauma observed in 2% versus 10% in the control group, and atelectasis in 8% versus 20%, respectively. These findings indicate a substantial protective effect of the implemented preventive care bundle. Duration of mechanical ventilation was shorter in the intervention group, with a mean duration of  $24 \pm 6$  hours compared to  $36 \pm 8$  hours in the control group ( $p < 0.05$ ). This reduction in ventilation time corresponded to decreased ICU stay, with patients in the intervention group discharged from the ICU after an average of  $3.5 \pm 1.2$  days versus  $5.2 \pm 1.6$  days in the control group. Postoperative oxygenation and pulmonary function improved more rapidly in the intervention group.  $\text{PaO}_2/\text{FiO}_2$  ratios were higher at 24 and 48 hours postoperatively, and patients demonstrated earlier recovery of baseline lung capacity. Additionally, the overall incidence of postoperative complications, including sepsis and prolonged hospital stay, was significantly lower in the intervention group (12% vs. 28%,  $p < 0.05$ ). No significant adverse effects related to the preventive interventions were observed, indicating that the care bundle was safe and feasible in a clinical setting. Compliance with the protocol, including head-of-bed elevation, oral care, and early mobilization, was over 90%, reflecting the practicality of these measures in routine practice. In summary, the results demonstrate that the structured preventive strategies effectively reduce ventilator-associated complications, shorten the duration of mechanical ventilation and ICU stay, and improve postoperative pulmonary outcomes. The findings support the adoption of comprehensive, evidence-based protocols for the management of patients undergoing pulmonary and airway surgery.

**Discussion:** The results of this study clearly demonstrate the effectiveness of a structured preventive care bundle in reducing ventilator-associated complications (VACs) among

patients undergoing pulmonary and airway surgery. The significant reduction in the incidence of ventilator-associated pneumonia (VAP), barotrauma, and atelectasis highlights the critical importance of implementing evidence-based perioperative strategies. These findings are consistent with previous studies, which emphasize that multidisciplinary interventions, strict adherence to aseptic techniques, and optimized ventilator management significantly decrease postoperative respiratory complications. Ventilator-associated pneumonia remains a leading cause of postoperative morbidity and mortality in thoracic surgery. The current study reinforces the role of combined preventive measures, such as head-of-bed elevation, oral hygiene, and perioperative antibiotic prophylaxis, in minimizing the risk of bacterial colonization and aspiration. Additionally, early mobilization and respiratory physiotherapy contributed to improved pulmonary function, accelerated recovery, and shorter ICU stays, which are crucial factors for overall patient outcomes and hospital resource utilization. Mechanical ventilation itself poses inherent risks, including ventilator-induced lung injury, alveolar overdistension, and impaired mucociliary clearance. By carefully adjusting ventilator settings, including tidal volume, PEEP, and respiratory rate, the intervention group experienced fewer complications, supporting the concept of lung-protective ventilation strategies. These adjustments, combined with rigorous infection prevention measures, created a synergistic effect that minimized both infectious and non-infectious ventilator-associated complications. Importantly, the study demonstrates that such preventive interventions are feasible and safe in a clinical setting. High compliance rates (>90%) indicate that the measures can be realistically implemented without significant disruption to routine clinical care. No adverse events directly related to the preventive protocol were observed, emphasizing both the practicality and safety of these strategies. Overall, the findings underscore the necessity of a proactive, multidisciplinary approach in pulmonary and airway surgery to mitigate the risks associated with mechanical ventilation. Integrating standardized care bundles into perioperative protocols can lead to significant improvements in patient safety, reduce postoperative complications, shorten ICU and hospital stays, and enhance overall surgical outcomes. Continuous education, staff training, and protocol monitoring are essential to sustain the effectiveness of these preventive strategies.

**Conclusion:** The study demonstrates that the implementation of a structured preventive care bundle significantly reduces the incidence of ventilator-associated complications in patients undergoing pulmonary and airway surgery. Key interventions, including optimized

ventilator management, strict aseptic techniques, perioperative antibiotic prophylaxis, head-of-bed elevation, oral hygiene, and early mobilization, collectively contributed to improved pulmonary function, reduced duration of mechanical ventilation, shorter ICU stays, and lower rates of postoperative infections. These findings highlight the critical importance of evidence-based, multidisciplinary strategies in perioperative care to enhance patient safety and surgical outcomes. The preventive measures were found to be both feasible and safe, with high compliance rates and no significant adverse effects. Incorporating these standardized protocols into routine clinical practice can substantially improve postoperative recovery, minimize morbidity, and optimize resource utilization in thoracic and airway surgery. Continuous staff training, monitoring, and adherence to preventive guidelines remain essential to maintaining the long-term effectiveness of these interventions.

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