

Ventilator Management: Foundations for Bedside Implementation

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Mechanical ventilation is a life-sustaining intervention in critical care, yet its improper application can lead to significant morbidity and mortality.¹ Optimising ventilator setup and ensuring timely, safe liberation are critical challenges for clinicians at the bedside. The ATS 2026 session, "FROM VENTILATOR SETUP TO LIBERATION: PRACTICAL FOUNDATIONS AND IMPLEMENTATION AT THE BEDSIDE," addresses these core principles, emphasising evidence-based strategies to improve patient care.

KEY TAKEAWAYS

- ° The Pivot: Emphasis on practical, evidence-based implementation of ventilator management from initiation to liberation.
- ° The Data: Focus on physiological principles guiding lung-protective ventilation and weaning protocols.
- ° The Action: Clinicians should reinforce foundational knowledge in ventilator modes, settings, and liberation criteria to minimise complications and improve patient outcomes.

Mechanical ventilation supports gas exchange in patients with respiratory failure, but its application carries inherent risks, including ventilator-induced lung injury (VILI) and ventilator-associated pneumonia (VAP).¹ The primary goal is to maintain adequate oxygenation and ventilation while minimising harm to the lungs and diaphragm.² This requires a comprehensive understanding of ventilator modes, initial settings, and ongoing management strategies.³ Respiratory failure, a common reason for ICU admission, can stem from various etiologies such as severe pneumonia, acute exacerbations of chronic obstructive pulmonary disease (COPD), acute respiratory distress syndrome (ARDS), and neuromuscular disorders. The prevalence of mechanical ventilation in critically ill patients underscores the importance of proficient management to improve patient outcomes and reduce morbidity and mortality.³

Practical Foundations in Ventilator Management

Initial ventilator setup involves selecting an appropriate mode, such as volume-controlled (VCV) or pressure-controlled (PCV) ventilation, based on patient physiology and clinical objectives.⁴ VCV delivers a set tidal volume with a variable inspiratory pressure, while PCV delivers a set inspiratory pressure with a variable tidal volume. The choice between these modes often depends on the clinician's familiarity, patient comfort, and specific lung mechanics. Lung-protective ventilation strategies are paramount, particularly in acute respiratory distress syndrome (ARDS), advocating for low tidal volumes (4-8 mL/kg predicted body weight) and plateau pressures less than 30 cm H₂O.⁵ These strategies aim to prevent overdistension and cyclic opening and closing of alveoli, which contribute to VILI. Positive end-expiratory pressure (PEEP) is applied to prevent alveolar collapse and improve oxygenation, with optimal levels often determined by

titration strategies to balance oxygenation and hemodynamics.⁶ High PEEP levels can improve oxygenation but may also impair venous return and cardiac output, necessitating careful monitoring of hemodynamic parameters. Individualised PEEP titration, often guided by bedside lung mechanics or imaging, is crucial for optimising respiratory support.

Monitoring ventilator parameters is continuous and includes assessing tidal volume, respiratory rate, minute ventilation, peak inspiratory pressure, and plateau pressure.⁷ Trends in these parameters provide insight into the patient's respiratory status and response to therapy. Arterial blood gas analysis provides crucial information on oxygenation and ventilation status, guiding adjustments to fraction of inspired oxygen (FiO₂), PEEP, and ventilator rate.⁸ Capnography, measuring end-tidal CO₂, offers a non-invasive, real-time assessment of ventilation effectiveness. Patient-ventilator asynchrony, a common issue, can increase work of breathing, prolong ventilation, and worsen outcomes.⁹ Types of asynchrony include flow asynchrony, trigger asynchrony, cycle asynchrony, and mode asynchrony. Strategies to mitigate asynchrony include adjusting ventilator settings, optimising sedation, and considering neuromuscular blockade in severe cases.¹⁰ Adequate sedation is essential to reduce patient discomfort and improve synchrony, but excessive sedation can prolong ventilation and increase the risk of complications. Neuromuscular blockers are reserved for severe ARDS or refractory asynchrony to facilitate lung-protective ventilation and reduce oxygen consumption.

The process of ventilator liberation, or weaning, begins when the underlying cause of respiratory failure has improved and the patient meets specific readiness criteria.¹¹ These criteria typically include adequate oxygenation with minimal FiO₂ and PEEP, hemodynamic stability, and resolution of severe acidosis.¹² Other important factors include a clear airway, effective cough, and absence of significant fever or infection. Spontaneous breathing trials (SBTs) are a cornerstone of liberation protocols, often conducted using a T-piece or low levels of pressure support.¹³ During an SBT, the patient's ability to maintain adequate gas exchange and respiratory effort without full ventilatory support is assessed. A successful SBT, typically lasting 30-120 minutes, indicates the patient's readiness for extubation.¹⁴ Failure of an SBT may necessitate further investigation into underlying issues or a more gradual weaning approach.

Post-extubation care focuses on monitoring for respiratory distress, managing secretions, and providing non-invasive respiratory support if necessary.¹⁵ High-flow nasal cannula or non-invasive positive pressure ventilation (NIPPV) can reduce the risk of reintubation in select patients. Early mobilisation and rehabilitation are also critical components of recovery, aiming to reduce deconditioning and improve functional outcomes.¹⁶ Physical therapy and occupational therapy initiated early in the ICU stay can mitigate muscle weakness and improve long-term physical function, addressing the significant issue of post-intensive care syndrome (PICS).¹⁸

While the principles of mechanical ventilation are well-established, their effective implementation at the bedside requires ongoing education and adherence to evidence-based protocols.¹⁷ The session at ATS 2026 aims to reinforce these practical foundations, ensuring clinicians are equipped with the knowledge to optimise ventilator management from initiation to liberation, thereby improving patient safety and outcomes.¹⁸ Continuous professional development and regular review of current guidelines are essential for maintaining proficiency in this complex area of critical care medicine.

CLINICAL IMPLICATIONS

The persistent focus on foundational ventilator management at major conferences like ATS 2026 underscores a critical gap in consistent bedside practice. Despite decades of research establishing lung-protective

ventilation and structured weaning protocols, adherence remains variable. This isn't a failure of innovation, but rather of implementation. The emphasis on "practical foundations" suggests that many clinicians, particularly those rotating through critical care, may lack a deep, intuitive understanding of ventilator mechanics and patient physiology. It's a reminder that the most sophisticated ventilators are only as good as the hands operating them.

For patients, the implications of suboptimal ventilator management are severe, ranging from prolonged ICU stays and increased risk of VILI to higher mortality. The push for reinforcing basic principles is a direct response to these patient safety concerns. It highlights that the industry's drive for advanced ventilator features must be matched by a renewed commitment to basic competency. Perhaps a more standardised, simulation-based training curriculum, mandated by bodies like the American Board of Internal Medicine or the European Society of Intensive Care Medicine, could elevate the baseline proficiency across all practitioners, not just intensivists. The continued need to discuss "practical foundations" suggests that the current educational models, relying heavily on didactic lectures and on-the-job training, are insufficient. Pharmaceutical companies and medical device manufacturers, while not directly involved in clinical guidelines, have a vested interest in ensuring their products are used effectively. Sponsoring educational initiatives that focus on core competencies, rather than just product features, could be a valuable contribution. Ultimately, the goal is not just to prevent complications, but to expedite liberation, reducing the burden on patients, healthcare systems, and the increasingly strained critical care workforce.

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