

ICU Respiratory Management: ARDS, VAP, COVID-19, ECMO

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Introduction

Respiratory care in the intensive care unit (ICU) is a complex and dynamic field that addresses a spectrum of critical respiratory conditions, demanding a high level of expertise and sophisticated management strategies. The management of acute respiratory distress syndrome (ARDS), a severe form of lung injury, remains a central focus, with ongoing research into optimizing ventilation and adjunctive therapies to improve patient outcomes [1]. Severe pneumonia, often bacterial or viral in origin, presents another significant challenge, requiring prompt diagnosis and targeted antimicrobial treatment alongside respiratory support [1]. Exacerbations of chronic respiratory diseases, such as chronic obstructive pulmonary disease (COPD) and asthma, can lead to acute respiratory failure, necessitating intensive care interventions to stabilize the patient and prevent further decline [1].

Optimizing mechanical ventilation is a cornerstone of ICU respiratory care, with a primary goal of providing adequate gas exchange while minimizing ventilator-induced lung injury. Lung-protective ventilation strategies, characterized by low tidal volumes and appropriate positive end-expiratory pressure (PEEP), have become standard practice for patients with ARDS [2]. Weaning patients successfully from mechanical ventilation is a critical phase that requires careful assessment of respiratory muscle strength and gas exchange, as premature or delayed weaning can lead to adverse outcomes [3]. Advanced therapies, such as extracorporeal membrane oxygenation (ECMO), are reserved for patients with severe respiratory failure who do not respond to conventional treatments, offering a potential bridge to recovery [4].

Infection prevention is paramount in the ICU to mitigate the risk of healthcare-associated infections, particularly ventilator-associated pneumonia (VAP). Robust infection control measures, including meticulous hygiene practices and appropriate use of antibiotics, are essential for reducing VAP rates and associated complications [5]. The management of severe exacerbations of chronic obstructive pulmonary disease (COPD) often involves a combination of bronchodilators, systemic corticosteroids, antibiotics, and ventilatory support. Non-invasive ventilation (NIV) is frequently employed as a first-line treatment for hypercapnic respiratory failure in COPD patients [6].

The COVID-19 pandemic has profoundly impacted ICU respiratory care, highlighting the challenges of managing critically ill patients with novel viral pneumonia. Adaptations of established ARDS management protocols, including mechanical ventilation strategies, have been crucial in caring for these patients [7]. Prone positioning has emerged as a recognized strategy for improving oxygenation in patients with moderate to severe ARDS, and its application in conjunction with mechanical ventilation has demonstrated a reduction in mortality [8].

Diagnostic tools play a vital role in the timely and accurate assessment of respiratory conditions in the ICU. Lung ultrasound has become an indispensable tool for diagnosing and monitoring various respiratory issues, including ARDS, pulmonary edema, and pleural effusions, allowing for rapid clinical decision-making [9]. The increasing prevalence of antibiotic resistance presents a significant threat to respiratory care in the ICU, complicating the management of VAP and other severe respiratory infections and necessitating judicious antibiotic stewardship [10].

The initial management of ARDS, while rooted in lung-protective ventilation, is continuously evolving with exploration of different ventilator settings, prone positioning, neuromuscular blockade, and fluid management. Adjunct therapies such as inhaled nitric oxide and ECMO are still under investigation for specific patient subgroups to reduce mortality and morbidity [2]. Weaning from mechanical ventilation is a critical phase where accurate assessment of respiratory muscle strength, adequate gas exchange, and resolution of the underlying cause of respiratory failure are paramount for successful outcomes and preventing reintubation or prolonged ICU stays [3].

ECMO has increasingly been utilized as a life-saving therapy for severe respiratory failure unresponsive to conventional treatments, offering an alternative to prolonged mechanical ventilation in ARDS cases. However, its application requires careful patient selection due to significant associated risks and the need for specialized expertise and resources [4]. VAP continues to be a major concern, contributing to increased morbidity and mortality, thus emphasizing the importance of prevention strategies such as elevating the head of the bed, regular oral care, and appropriate sedation management [5].

Severe exacerbations of COPD requiring ICU admission are managed with bronchodilation, systemic corticosteroids, antibiotics, and ventilatory support, with NIV being a common initial approach for hypercapnic respiratory failure. Invasive ventilation becomes necessary for patients who fail NIV or present with other complications [6]. The COVID-19 pandemic underscored the importance of adaptable respiratory care strategies, utilizing high-flow nasal cannula oxygen, NIV, and mechanical ventilation tailored for severe viral pneumonia and ARDS [7].

Prone positioning has demonstrated efficacy in improving oxygenation for ARDS patients and has been linked to reduced mortality when combined with mechanical ventilation. Successful implementation hinges on careful patient selection, monitoring, and a skilled multidisciplinary team to manage potential complications [8]. Lung ultrasound has proven invaluable in the ICU for diagnosing and monitoring a range of respiratory conditions, providing rapid, non-invasive insights that can guide immediate clinical decisions regarding fluid management and ventilation adjustments [9].

The growing challenge of antibiotic resistance in ICUs directly impacts the man-

agement of respiratory infections, particularly VAP. Strategies to combat this threat involve prudent antibiotic stewardship, the judicious use of novel antimicrobial agents, and the consistent implementation of effective infection prevention measures to preserve treatment options [10].

Description

The intensive care unit (ICU) is at the forefront of managing complex respiratory conditions, with ARDS, severe pneumonia, and chronic respiratory disease exacerbations demanding a multifaceted approach. Optimizing mechanical ventilation strategies, including lung-protective ventilation with low tidal volumes and appropriate PEEP, is fundamental for ARDS management, with ongoing exploration of advanced settings and adjunct therapies to improve outcomes [1]. Successful weaning from mechanical ventilation is a critical juncture, predicated on accurate assessment of respiratory muscle strength and gas exchange, as suboptimal timing can lead to adverse events such as reintubation and prolonged ICU stays. Protocols and spontaneous breathing trials are essential guiding tools [3].

Advanced life support modalities like ECMO are reserved for severe respiratory failure unresponsive to conventional treatments, offering a vital alternative in ARDS cases. However, ECMO necessitates specialized expertise and careful patient selection due to its inherent risks [4]. Preventing ventilator-associated pneumonia (VAP) is a high priority, with evidence-based strategies including elevating the head of the bed, oral hygiene, and judicious sedation management playing a crucial role in reducing its incidence and associated complications [5].

For severe COPD exacerbations requiring ICU admission, management encompasses bronchodilation, systemic corticosteroids, antibiotics, and ventilatory support. Non-invasive ventilation (NIV) is frequently the initial choice for hypercapnic respiratory failure, with invasive ventilation reserved for cases unresponsive to NIV or complicated by other factors [6]. The COVID-19 pandemic underscored the adaptability required in critical care respiratory management, utilizing various ventilatory support methods, including adapted ARDSNet strategies, for severe viral pneumonia [7].

Prone positioning has been established as an effective intervention for enhancing oxygenation in ARDS patients, with evidence suggesting a reduction in mortality when employed alongside mechanical ventilation. This strategy requires meticulous patient selection, continuous monitoring, and a skilled multidisciplinary team to navigate potential complications [8]. Lung ultrasound has become an indispensable diagnostic tool in the ICU, enabling rapid, non-invasive assessment of conditions such as ARDS, pulmonary edema, and pleural effusions, thereby facilitating timely clinical decisions and guiding interventions [9].

The pervasive issue of antibiotic resistance in ICUs poses a substantial threat to the management of respiratory infections, especially VAP. Combating this challenge involves implementing robust antibiotic stewardship programs, utilizing newer antimicrobial agents judiciously, and reinforcing infection prevention measures to preserve treatment efficacy [10]. The management of ARDS is characterized by evolving strategies beyond lung-protective ventilation, investigating various ventilator settings, prone positioning, neuromuscular blockade, and fluid management. Adjunctive therapies like inhaled nitric oxide and ECMO are continuously evaluated for specific patient groups to mitigate mortality and morbidity [2].

Weaning from mechanical ventilation is a pivotal phase in ICU care, relying on precise evaluation of respiratory muscle strength and adequate gas exchange. The resolution of the underlying cause of respiratory failure is also critical for successful weaning and avoiding negative outcomes like reintubation and extended ICU stays [3]. Extracorporeal membrane oxygenation (ECMO) has emerged as a crucial in-

tervention for severe respiratory failure that is refractory to conventional therapies. In ARDS, ECMO can serve as an alternative to prolonged mechanical ventilation, though it carries significant risks and demands specialized resources and expertise, making careful patient selection paramount [4].

Ventilator-associated pneumonia (VAP) remains a significant clinical problem in ICUs, contributing to increased patient morbidity, mortality, and healthcare costs. Prevention remains the most effective approach, incorporating strategies such as elevating the head of the bed, performing regular oral care, managing sedation appropriately, and ensuring timely changes of ventilator circuits [5]. The management of severe COPD exacerbations in the ICU necessitates a comprehensive approach involving bronchodilation, systemic corticosteroids, antibiotics, and appropriate ventilatory support. Non-invasive ventilation (NIV) is frequently the initial strategy for managing hypercapnic respiratory failure in these patients, with invasive ventilation considered when NIV is insufficient or other complications arise [6].

The global COVID-19 pandemic has significantly influenced ICU respiratory care, emphasizing the need for flexible management of critically ill patients with novel viral pneumonia. Strategies employed range from high-flow nasal cannula oxygen and NIV to mechanical ventilation, with ARDSNet ventilation principles adapted for severe cases. Ongoing research into treatments and vaccines continues to shape long-term patient care [7]. Prone positioning is a well-established method for improving oxygenation in patients with moderate to severe ARDS. Its integration with mechanical ventilation has been associated with reduced mortality rates, but it requires careful patient selection, vigilant monitoring, and a skilled team to manage potential complications [8].

Lung ultrasound has become an integral diagnostic modality in the ICU for addressing a variety of respiratory conditions, including ARDS, pulmonary edema, and pleural effusions. Its non-invasive and rapid nature aids in prompt clinical decision-making and can guide interventions such as fluid management and ventilator settings [9]. The escalating problem of antibiotic resistance in ICUs complicates the treatment of VAP and other severe respiratory infections. Effective management strategies include judicious antibiotic stewardship, the use of newer antibiotics, and rigorous implementation of infection prevention measures [10].

Conclusion

Critical care respiratory management in the ICU addresses complex conditions like ARDS, severe pneumonia, and chronic respiratory exacerbations. Key interventions include optimizing mechanical ventilation with lung-protective strategies, successful weaning protocols, and advanced therapies such as ECMO for refractory cases. Prevention of ventilator-associated pneumonia (VAP) through stringent infection control measures is crucial. Management of severe COPD exacerbations involves bronchodilators, corticosteroids, antibiotics, and ventilatory support, often initiating with NIV. The COVID-19 pandemic has influenced care protocols. Prone positioning improves oxygenation in ARDS, and lung ultrasound serves as a vital diagnostic tool. Antibiotic resistance remains a significant challenge, necessitating antibiotic stewardship and infection prevention. The field continues to evolve with new research and adaptive strategies.

Acknowledgement

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Conflict of Interest

None.

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