ERS Congress 2024: highlights from the Respiratory Intensive Care Assembly

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Advances in lung physiology, newer technologies such as HFNC, and AI may help identify new diagnostic and therapeutic options to provide better care for our patients in the field of respiratory intensive care https://bit.ly/4b3CUl7

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In this editorial, the early career members of Assembly 2, Respiratory Intensive Care, present highlights from the 2024 European Respiratory Society (ERS) Congress held in Vienna, Austria. This summary encompasses sessions on basic physiology as well as innovative technologies and future developments in respiratory failure, delivered by international experts, and builds upon previous highlights reported by early career members [1, 2].

No developments in the field are possible without deepening the understanding of lung physiology. The past decades have brought us knowledge of the main mechanisms. However, the development is still ongoing.

One area of long-standing discussions is whether increased carbon dioxide tension (P_{CO_2}) should be tolerated in patients with acute respiratory distress syndrome (ARDS) to facilitate lung-protective ventilation. Hypercapnia has been associated with a variety of physiological effects, both protective and detrimental [3]. Hypercapnia is related to increased pulmonary artery pressure, potentially exacerbating right heart strain, particularly in patients with pre-existing pulmonary hypertension [4], while P_{CO_2} decrease during acute exacerbation of COPD (AECOPD) is associated with improved right heart function [5], and lower P_{CO_2} is also associated with lower pulmonary vascular resistance. Furthermore, hypercapnia can contribute to increased shunt fraction and an increase in systemic vascular resistance, complicating haemodynamic management in septic patients. Whether permissive hypercapnia should be tolerated in ARDS remains a topic of debate. The effects of CO_2 seemingly depend on its mechanism: protective effects are probably mediated by lung-protective ventilation, negative effects by pulmonary vascular dysfunction. Knowing the effects of CO_2 removal can show us alternatives to prolonged ventilation of patients with AECOPD [4], raising the question of whether too much CO_2 can be removed too rapidly, considering that CO_2 from body stores can be mobilised over 48 h without reaching a steady state [6].

The 2019 Nobel Prize in medicine was awarded for describing hypoxia-inducible factors that play a significant role in detecting hypoxia in the carotid bodies and triggering adaptive and maladaptive responses to hypoxia [7]. It has yet to be decided what degree of permissive hypoxaemia is still compatible with adaptive reactions. Hypoxia primarily affects high-oxygen-demand organs such as the brain, heart and gastrointestinal tract, where adaptive mechanisms may fail to meet metabolic needs. Notably, hypoxic injury in these organs can lead to severe complications, including neurological deficits, myocardial ischaemia and gut barrier dysfunction [8], which are associated with increased morbidity and mortality [9, 10].

Oxygen can be delivered by several devices. High-flow nasal cannula (HFNC) therapy, initially introduced for respiratory failure, is increasingly used in chronic settings [11]. One of the latest introductions is asymmetrical HFNC prongs, which show a reduction of minute ventilation and work of breathing in patients with mild-to-moderate hypoxaemic respiratory failure [12]. Asymmetrical HFNC prongs may be beneficial over symmetrical prongs due to better dead space clearance in upper airways, particularly at the nasal level due to pressure differences between the nares which allow for air to flow out through the smaller prong side in all breathing phases. Computational modelling of average European noses confirmed this finding, but what is more surprising is that the same model showed that nasogastric tube insertion in asymmetrical HFNC prongs is beneficial for CO_2 clearance from the nose due to asymmetric flow in between nares at high flow rate under normal and high respiratory frequencies [13].

In chronic settings, HFNC has primarily been studied in COPD patients [14]. Although data for interstitial lung diseases (ILDs) are limited, they are promising. Studies suggest that the impact of HFNC on life expectancy in hypoxaemic ILD patients is comparable to noninvasive ventilation (NIV), but better tolerated [15]. A physiological study on fibrotic and predominantly hypercapnic ILD patients demonstrated a decrease in CO_2 levels and reduction of respiratory rate and minute volume after 8 h of HFNC use [15]. Thus, HFNC should be considered a viable treatment option for ILD patients, particularly those enrolled in lung transplant programmes.

High-intensity NIV has improved survival in hypercapnic stable COPD patients [16]. However, home NIV has been shown to be ineffective in 25% of its users [17]. One potential explanation may be the laryngeal adductor reflex, also known as glottic closure reflex, which can be triggered by air pressure puffs, a transient burst of pressurised air delivered during NIV [18]. Laryngeal adduction was observed in five out of eight studied COPD NIV patients, and in all four patients exposed to inspiratory pressure exceeding 24 cmH_2O [19]. This finding warrants further studies. While transnasal fibreoptic laryngoscopy (TFL) is the most reliable method for observing laryngeal adduction, it is invasive. Patients prefer noninvasive options. Recent data have shown a high level of agreement between laryngeal ultrasound and TFL [19].

Upper airway closure complicates secretion management during the use of cough assist devices. Adjusting inspiratory settings might improve cough effectiveness. In a study of Duchenne muscular dystrophy patients, prolonging inspiratory time from 2 to 3 s and increasing inspiratory rise time resulted in modest improvements. Peak cough flow *versus* peak inspiratory flow ratio (used as one of the effectiveness markers) increased consequently in five and eight of 12 studied patients, respectively [20, 21]. Nonetheless, upper airway obstruction persisted despite adjusted settings. Therefore, it may be more promising to focus on upper airway obstruction than on investigating the inspiratory settings [20, 21]. Furthermore, artificial intelligence (AI) may help to identify further treatment options.

The global use of AI is on the rise, and its capacity to analyse big data for predicting outcomes in respiratory medicine should be leveraged for the benefit of clinicians [22, 23]. AI's role in precision medicine is expanding, leading to improved outcomes in personalised oxygen therapy [24] and potentially paving the way for personalised ventilation [25] and automated weaning in the future. Although AI's capabilities are not yet fully developed, its potential to prevent respiratory failure offers promising results for the future.

The design of new therapies for ARDS necessitates the advancement of precision medicine that incorporates phenotypes at the point of care [26]. The hyper-inflammatory systemic host response in ARDS has been consistently linked to increased mortality. Consequently, therapeutic options that target this phenotype (such as baricitinib, tocilizumab and complement inhibitors) may be effective in improving outcomes [27].

Telemedicine can assist in the various stages of establishing home mechanical ventilation (HMV). However, it cannot yet replace traditional consultations, due to the complex nature of HMV and the need for in-person evaluations for accurate patient selection, phenotyping and education. The detection of leaks, HMV use, obstructions and asynchronies during monitoring *via* telemedicine is commonly employed [28], and the potential for real-time monitoring is growing. Nonetheless, questions remain regarding which variables should be analysed. Monitoring asynchronies is complex, and no clear relationship with improvements in gas exchange has been established, although associations between asynchronies and quality of life have been noted. Improved gas exchange is linked to better outcomes, but monitoring still poses challenges. The role of telemedicine in initiation is less clearly defined; however, its application for home initiation seems feasible, cost-effective and preferred by patients, yielding results comparable to those of in-hospital initiation [29]. Moreover, there is positive patient feedback regarding outpatient initiation [30].

Telemonitoring appears to be well received by patients and currently represents the primary application for these technologies. It offers theoretical benefits for identifying HMV patients who require attention to enhance outcomes, reduce costs and decrease hospital visits; however, documented benefits remain limited. Despite the vast amount of available data, optimal usage strategies remain unclear. The multicomponent approach to telemonitoring includes patient education, real-time monitoring of ventilatory parameters, early detection of exacerbations, and personalised adjustments to ventilator settings. This strategy aims to enhance adherence, improve quality of life and reduce hospital admissions by integrating clinical feedback loops into home-based care [28, 31].

In conclusion, advancements in lung physiology, innovative technologies such as HFNC, and the integration of AI may help to identify new diagnostic and therapeutic options to provide better care for our patients in the field of respiratory intensive care.

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