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Exploring the Impact of Pneumonia on Mechanical Ventilation

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Abstract:
Pneumonia, an infection leading to inflammation of air sacs present in one or both lungs, commonly causes symptoms such as cough, chest pain, fever, and breathing difficulty. The main objective of the present study was to review the updates of cited literature regarding the impact of pneumonia on mechanical invitation. To achieve this objective, the researcher referred to the most popular search engines, such as PubMed, Google Scholar, Science Direct, and others. This review indicated that pneumonia and mechanical ventilation are important topics in medicine, particularly emergency medicine.

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INTRODUCTION

Pneumonia, an infection leading to inflammation of air sacs present in one or both lungs, commonly causes symptoms such as cough, chest pain, fever, and breathing difficulty (Janssens *et al.*, 2021). In some cases, especially in severe pneumonia, the patient may require respiratory support in the form of mechanical ventilation for the maintenance of adequate oxygenation and ventilation (Huang *et al.*, 2022). Pneumonia requiring ventilatory support may encompass a diverse nature of microbial hosts, strengths, types of lung infiltration like bronchopneumonia, lobar pneumonia, complicated and non-complicated pneumonia, and last but not least, the host's state of immunity. Each of these variants opens a new level of complexity and creates a unique set of challenges not just for the physician, but also for the nursing professionals attending to such patients (Rackley, 2020). This point of view draws attention to the following points: reasons, why some obstruct the ventilation of one or both lungs, and influence other body parts, thereby causing systemic problems, for example, affecting heart function, leading to other body parts not getting a sufficient supply of oxygen to perform their normal function, the contrasting beliefs of patients and physicians, and a brief overview of ventilator-associated pneumonia (Broadhurst *et al.*, 2022; Gosangi *et al.*, 2022; Karunarathna *et al.*, 2024b; Karunarathna *et al.*, 2024d).

Mechanical ventilation is done when enough oxygen is not delivered to the body owing to very slow or no breathing or to reduce work imposed on overstressed muscles in patients with infectious illnesses or patients who cannot move (Nascimento-Carvalho, 2020). Most patients with community-acquired pneumonia can be managed on an outpatient basis, while others who have severe pneumonia, pneumonic consolidation on chest X-ray, known or chronic heart/lung disease, or compromised immunity benefit from either invasive mechanical ventilation, noninvasive positive pressure ventilation, or high-flow oxygen therapy (Andersen and Pant, 2022). Healthcare professionals managing patients with pneumonia who require ventilatory assistance face a peculiar set of challenges, the most important of which is to balance between ventilation and ventilator injury, including ventilator-associated pneumonia (Jones *et al.*, 2020). More often than not, the patients are already very sick, wherein the antibacterial used is based on personal and institutional beliefs without considering the local immune status of the pneumonia-promoting microbial entity likely to be causing pneumonia in particular; their beliefs about the probable cause of pneumonia are mostly in contrast to each other (Rejas *et al.*, 2022). A vigorous set of pathophysiological and traditional microbiological studies has come out with certain labeled findings such that the reason pneumonia patients tend to have a higher heart rate is due to reduced carbon dioxide elimination in severe, life-threatening respiratory failure states. Pneumonia due to bacteria has different clinical severity related to host resistance for the same species. In some cases, consolidation or incursion in lung percussion changes on chest examination may be completely different (Tillotson *et al.*, 2020).

Pathophysiology of Pneumonia

Pneumonia is a bacterial infection that incites significant inflammation and damage to the lungs (Long *et al.*, 2022). Although viral infections also lead to damage of a similar extent, much of the damage from acute respiratory viral pandemics is indirect and brought on by the immune system (Kumar, 2020). The underlying symptoms of pneumonia, including productive cough, fever, and malaise, relate to the body's immune response to the organisms, as much as they do to the organisms themselves (Stotts *et al.*, 2023). Macrophages and neutrophils begin to attack the pathogens in acute pneumonia. The injured cells of the alveoli are incapable of protecting the tissue further. They further release proteases and inflammatory substances that damage the tissue (Land, 2021). This inflammation can reduce lung volume, and lung compliance, and cause life-threatening respiratory failure. Lung injury then leads to a number of significant pathophysiological changes. Defense against bacteria during acute pneumonia results in inflammatory septal damage (Badraoui *et al.*, 2021). This inflammation and the increased pressure in the alveoli allow fluid to move into the tissue from the blood and alveoli (Lara *et al.*, 2020). The body's ability to maintain the pressure and provide oxygen to the blood through the tissue is reduced (Land, 2021). Damage to the alveolar-capillary membrane ensues with eventual disruption of the cytoskeleton and cell death (Badraoui *et al.*, 2021). Pulmonary shunts may develop at this stage. Factors that affect the competition of pro-inflammatory substances or the inhibition of their release determine the amount of lung injury in various types of pneumonia (Al-Saghir *et al.*, 2015). Pulmonary shunting relates to the release of cytokines and other pro-inflammatory substances, making the hypoxia in ARDS refractory to increases in airway pressure. The development of hypoxemia in pneumonia underscores the degree to which this process has occurred (Mondeshki *et al.*, 2022).

Inflammatory Response

Pneumonia is a severe infection of the lung that poses an important burden for healthcare systems across the globe (Long *et al.*, 2022). The lung and its defense mechanisms are frequently affected by bacterial pneumonia. The immune system initially recognizes when its barriers to infection are breached by newly arrived pathogens (Huang *et al.*, 2022). Following the invasion of the alveolar space by commensal or nosocomial pathogens, a variety of sentinel immune cells become involved, including alveolar macrophages, type 2 alveolar cells, and dendritic cells (Waterer, 2021). These cells, through a panoply of pattern recognition receptors, start to release inflammatory mediators, including chemokines, cytokines, lipid metabolites, and interferons (Mah *et al.*, 2022). Such signaling cascades recruit and manipulate other leukocytes to a point where they can impede the aggressor's replication or engulf and destroy it (Longhitano *et al.*, 2021). Signaling can either be via immune cells directly confronting pathogens in the alveoli of pneumonia patients or indirectly ensheathing them within a biofilm until the effective release of mucus and clearance occurs (Fonseca *et al.*, 2021). Despite these myriad cascades of events, pneumonia is still possible (Izumi and Akifusa, 2021). That is to say, the collateral damage caused to lung structure and function by aggressive leukocyte effectors and the quantities of mucus summoned for pathogen blockade and removal can compromise lung function to the point of breathing difficulties and excessive gas accumulation (Aithal *et al.*, 2023; Núñez-Fernández *et al.*, 2021).

Inflammation is another impact of the irritants that cause pneumonia, and your mind perceives this as a malfunction (Iqbal, 2021; Stotts *et al.*, 2023). More specifically, it is hyperirritant, causing supersession of the expected response (Kumar, 2020). It is defined physiologically as the center that is inhibited by large doses of drugs dissimilar to those that excite or, in other words, a deceptively simple concept (Waterer, 2021). The current clinical model to diagnose pneumonia utilizes simple clinical and paraclinical information like cough, fever, fast breathing, and diarrhea, whilst emphasizing that it cannot differentiate whether pneumonia is present due to viral or bacterial etiological causes (Sriram *et al.*, 2021). Nevertheless, a proportion of pneumonia-associated alveolar damage is caused when inflammation gets out of control and causes damage to normally resistant alveolar walls (Anderson and Feldman, 2023). This will result in increased work of breathing and the need for mechanical ventilation (Takahashi *et al.*, 2022). One technique to widen the airway and perhaps lessen or even completely eradicate these symptoms is mucolytic medication treatment (Ali *et al.*, 2019).

Alveolar Damage

Pathogens involved in pneumonia affect lung parts already affected by injury, regardless of whether the original cause of injury was viral, physical, or idiopathic (Clementi *et al.*, 2021). Acutely injured alveoli suffer from the overflow of pathogens and their products to the point that capillaries become engorged (Luyt *et al.*, 2020). The capillary blockade prevents red blood cells carrying oxygen from entering, limiting, and eventually shutting down the gaseous exchange—a pathological mechanism called shunt (Kosutova and Mikolka, 2021). Engorged alveolar capillaries force red blood cells against the capillary wall, where they release their hemoglobin content, including iron, transforming bacteria into active metabolizers with an increased growth rate (Georgakopoulou *et al.*, 2023; Hou *et al.*, 2022; Thibeault *et al.*, 2021). In addition, the accumulation of iron-damaged red blood cells leads to the progressive clearance of heme and iron from the alveoli (Bonaventura *et al.*, 2021).

As the latter are released during the uptake of red blood cells, iron rapidly increases in the alveolar fluid that bathes the lung and elicits potent inflammatory processes (Qureshi and Mustafa, 2018). In addition to the cessation of gas exchange, the result is the destruction of the alveolar walls. Such destruction has profound consequences (Manickavel, 2021). Alveolar walls, directly exposed to the inhaled air, provide the largest possible area for gaseous exchanges to occur, only fractionally thicker than a sheet of paper; their destruction reduces the total area over which exchanges can occur (Mason, 2020). The extent of destruction likely carries important clinical information, providing valuable cues to suggest the ventilatory strategy that should be adopted to treat a correctable problem (Battaglini *et al.*, 2023a; Ramirez-Estrada *et al.*, 2023). Instead of focusing on functional impairment as in pathophysiology, the remaining two paths will dwell on direct mechanisms of tissue injury (Kim *et al.*, 2024). Therefore, attention will be diverted from inflammation to mechanisms (Dimbath *et al.*, 2021; Zeng *et al.*, 2022). Data and far-reaching considerations will alternate with basic research regarding the role of these effectors in injury (Toth *et al.*, 2022).

Mechanical Ventilation in Pneumonia Patients

Mechanical ventilation is an important strategy in the management of patients with pneumonia. Indications include acute hypoxemic respiratory failure and/or severe sepsis and septic shock with refractory hypotension (Kózka *et al.*, 2020). The clinical importance of these recommendations is that, as hypotension is a common expression of sepsis-induced cardiovascular failure, there is a very limited amount of time available for the reversal of hypoperfusion, the restoration of cardiovascular function, and the treatment of occult hypoxemia (Alkhatib, 2021). Ventilatory settings may be very important for pneumonia (Liaqat *et al.*, 2022). Tidal volume can distribute the alveolar ventilation, oxygen concentration can increase the alveolar oxygen pressure, the ratio of the inspired oxygen concentration, and the average alveolar pressure, and the positive end-expiratory pressure to keep the alveoli open at the end of inhalation, which can influence the alveolar mechanics and the local immunity (Dupuis *et al.*, 2021; Johnstone *et al.*, 2021; Peng *et al.*, 2020; Sánchez-Guijo *et al.*, 2020). The choice of these settings may be influenced by the severity of pneumonia (Meawed *et al.*, 2021).

Correct ventilator strategies for patients with pneumonia are still topics of debate. International recommendations for mechanical ventilation are few (Alkhatib, 2021). The concept of protective mechanical ventilation ensured through dimensioning tidal volume, limiting airway pressure, and ensuring sufficient PEEP seems to be used in clinical practice at any stage of the disease (Papazian *et al.*, 2020). However, when this strategy is applied is deeply subjective and unstandardized (Howroyd *et al.*, 2024). Although a guideline might be considered feasible, it would only state clinical evidence in an average of intermediating physicians, who make many critical decisions, particularly in severe cases (Fally *et al.*, 2024). Typically, a standard evidence-based therapeutic goal is issued, and the degree of severity that describes the population does not apply to individual patients (Fernando *et al.*, 2020). Large-scale clinical studies were performed to observe disease outcomes and mortality in the overall population, including many cases of conservative treatment that had few reasons for mechanical ventilation (Goligher *et al.*, 2020). Political decisional guidelines propagate the concept that evidence from practice can help correct results, according to timely interventions, hence reducing the impact of chronic disease and the inadequacy of treatment and dose (Windisch *et al.*, 2020). General guidelines have failed to alleviate the ambiguity concerning conservative treatment (Pickens *et al.*, 2021).

Indications for Mechanical Ventilation

Pneumonia is one of the medical conditions that require mechanical ventilation (Kózka *et al.*, 2020). This suggests that it is a requirement for patients with pneumonia who may need ventilator support (Gragueb-Chatti *et al.*, 2021). Indications for mechanical ventilation have to do with an immediate and urgent clinical disentanglement of the patient who needs ventilatory and respiratory assistance (Ebrahimian *et al.*, 2021). The basis for the beginning of the mechanical ventilation of a patient with pneumonia is the clinical condition of acute respiratory failure, in which the immediate initiation of mechanical ventilatory support decreases morbidity, and fiscal costs of the illness, and saves lives most of the time (Marietta *et al.*, 2020). The conditions for the critical patient who may need mechanical ventilation are based on clinical judgment that requires the use of anamnesis, computed tomography, images, and laboratory results indicating the severity of the patient with pneumonia (Umemura *et al.*, 2021). Etiology is another factor in the decision-making for critical patients with pneumonia according to the extended spectrum of the pathogen (Assimakopoulos *et al.*, 2021). Arterial blood gas analysis is the ultimate marker for clinical decision-making in critically ill patients (Lima *et al.*, 2020).

In a patient with community-acquired pneumonia, mechanical ventilation should be initiated very soon in the absence or presence of clinical signs (Nair and Niederman, 2021). The absence of clinical signs includes moderate to severe hypoxemia at room air causing severe hypoxemia with clinical symptoms, the existence of hypercapnia, and type II respiratory failure confirmed by the $PaCO_2$ value and the pH value with a severe ratio with HCO_3 (Martin-Loeches *et al.*, 2023b). Clinical signs are represented by the need for airway protection and ventilatory assistance, impending death, clinical symptoms compared with a better-computed tomography image showing a more extensive infiltrate, and other related clinical aspects (Ferrer *et al.*, 2024; Yang and Shu, 2024). It is most important for the discussants and teachers of pulmonology to know the criteria for initiating mechanical ventilation in a patient with pneumonia (Deshpande *et al.*, 2022).

Ventilator Settings

One of the key factors affecting outcomes in mechanically ventilated patients with pneumonia in terms of lung-protective ventilation, which has a positive impact on patients, is the setting and adjustment of the ventilator according to the patient's response (Diehl *et al.*, 2020; Hassan *et al.*, 2021; Liu and Wang, 2022). The aim of mechanical ventilation, especially in patients with pneumonia, is to maintain appropriate gas exchange in the blood, re-expand collapsed lungs, and unload the respiratory muscles until the underlying pathology leading to the need for mechanical ventilation is resolved (Astasio-Picado *et al.*, 2022; Gupta *et al.*, 2021; Hurry, 2024; Lehingue *et al.*, 2022; Pelosi *et al.*, 2022; Wong *et al.*, 2022).

Adjusting ventilator parameters such as tidal volume, respiratory rate, and fraction of inspired oxygen has long been seen as the standard of care in most intubated patients with pneumonia (Grasselli *et al.*, 2021). Starting in 1996, a system began designing static parameters of ventilation that would be lung-protective when applied across groups of patients who had been classified as having ARDS (Rackley, 2020). Moving forward, however, research has shown the need for individual patient care and adjustment of mechanical ventilatory parameters following patient response (Nolley *et al.*, 2023). Although an open lung strategy begins with a minimum value for PEEP, a minimum FiO_2, and setting the tidal volume and respiratory rate to achieve adequate minute ventilation, actual ventilatory settings and parameters may be repeatedly titrated (Battaglini *et al.*, 2021). Initial ventilator settings in intubated patients appear in a referenced table. Since optimal ventilator settings often lean heavily on the patient's underlying pathophysiology of lung failure, they may be adjusted according to the patient's or the disease process's performance and response to the chosen ventilator parameters (Calligaro *et al.*, 2020; Peña-López *et al.*, 2024).

Overall, restricted tidal volume and plateau pressure are important for ensuring lung protection, but adequate oxygenation and ventilation can only be established if all three parameters are combined, adjusted based on response and outcome, and regularly checked and rechecked throughout the patient's clinical course (Guidet *et al.*, 2024). Baseline ventilator support settings in non-intubated and intubated patients are provided for informational purposes in a referenced table (Duggal *et al.*, 2024; Reynolds *et al.*, 2021). Titration and management of the settings described in the referenced table belong to those professionals experienced in critical care and advanced airway management (Chen *et al.*, 2022; D'Cruz *et al.*, 2023; Motes *et al.*, 2023). Clearly, adjustment of these strategies will rely heavily on factors such as patient response and trajectory of illness, and it is beyond the scope of this document to advise on specific parameters of such strategies, especially with debate about appropriate oxygen targets in the literature (Ewers and Lehmann, 2022; Hess *et al.*, 2020; Hughes *et al.*, 2024).

Complications of Mechanical Ventilation in Pneumonia Patients

Mechanical ventilation may be required in patients with pneumonia due to the worsening of respiratory conditions and in case of failure of noninvasive ventilation support, high-flow oxygen from a nasal cannula, and standard oxygen therapy (Karunarathna *et al.*, 2024a; Pagliano *et al.*, 2021). Mechanical ventilation can be a lifesaving intervention, increasing the possibility of survival in patients with hypoxemic respiratory failure and even in more stable patients with pneumonia. However, the application of mechanical ventilation can be associated with several complications (MacLeod *et al.*, 2021).

Indeed, it is essential to appreciate that the use of mechanical ventilation involves a potential "so-called vicious circle" where the benefits of mechanical life support are balanced against the iatrogenic complications of intrusive mechanical life support (Patil *et al.*, 2022). In this regard, mechanical ventilation can exacerbate pulmonary inflammation in patients with pneumonia, leading to ventilator-associated pneumonia and the occurrence of barotrauma, air leaks, nosocomial pneumonia, and impaired oxygenation (Bordon *et al.*, 2021). The development of barotrauma and altered lung compliance also increases the risk for supportive care strategies such as prone positioning and increased positive end-expiratory pressure required in some patients (Bai *et al.*, 2022; Ziaka and Exadaktylos, 2021).

Several complications can occur during mechanical ventilation, which may affect outcomes during severe pneumonia (Papazian *et al.*, 2020). Ventilator-associated pneumonia is probably the best studied, and many comprehensive and current guidelines are available for clinicians to aid in the prevention, diagnosis, and management of ventilator-associated pneumonia (Shah *et al.*, 2022). Ventilator-associated pneumonia can lead to an increased intensive care unit length of stay, an increased need for sedation and paralytics, and an increased need for mechanical ventilation in addition to increased morbidity and mortality (Coelho *et al.*, 2023). Peri-intubation-related hypoxemia can occur as a result of aspiration of gastric contents, post-intubation atelectasis, or aspiration of infective respiratory secretions from the upper airway, and increases in driving pressure can lead to an increased risk of pulmonary barotrauma (Luo *et al.*, 2021). Gastric insufflation is the most important risk factor for refractory hypoxemia in a profoundly hypoxemic pneumonia patient (Savary *et al.*, 2020). Other complications of mechanical ventilation include the development of extra-pulmonary organ dysfunction (Luque-Paz *et al.*, 2021). With improvements in mechanical ventilator technology, the incidence of barotrauma continues to decrease, particularly in COVID-19, whereas that of volutrauma or atelectrauma might be higher in late-presenting COVID-associated pneumonia patients, although whether this is the case will require data from controlled studies (Szarpak *et al.*, 2021).

Ventilator-Associated Pneumonia

Over the past several decades, there has been a significant increase in the number of available data and the range of research surrounding Ventilator-Associated Pneumonia (VAP) (Omwenga, 2020). As such, the understanding of this condition has been greatly enhanced (Llitjos *et al.*, 2021). Herein, VAP is addressed as an isolated entity, despite its broad scope (Cui *et al.*, 2023). VAP denotes the infection of lung parenchyma distal to the trachea and the mainstem bronchus that develops forty-eight hours after the initiation of mechanical ventilation (Peña-López *et al.*, 2022). VAP occurs in fourteen to seventy-six percent of patients subjected to mechanical ventilation, depending on the presence of pneumonia (Tuyambaze and Hakizimana, 2023). Moreover, up to fifty percent of pneumonia cases are receiving mechanical ventilation (Thomas *et al.*, 2021). VAP is unlikely to develop in the absence of pneumonia (Megahed *et al.*, 2021). At the same time, it is the leading infectious complication of patients subjected to mechanical ventilation (Taha *et al.*, 2022). Mechanical ventilation may increase the risk of pneumonia development due to aspiration and interfere with the drainage of oropharyngeal secretions (Tang *et al.*, 2023). Moreover, the endotracheal tube impairs the cough reflex and mucus clearance (Alkhatib and Ababneh, 2021).

The greatest risk factor for developing VAP is the length of time during which the patient remains on mechanical ventilation (Kózka *et al.*, 2020). In addition, all other risk factors contribute to the increase in the time of mechanical ventilation (Núñez *et al.*, 2021). In the presence of pneumonia and undergoing mechanical ventilation, these risk factors could be subdivided into host-dependent (old age, very young age, immunosuppression, comorbidities, and sepsis) and those induced by the patient reception (antibiotics, sedation, vasopressors), mechanical ventilation (trauma, aspiration), and uncontrolled sources of infection in nine identifiable microbial foci (unsterilized devices and equipment) (Liu *et al.*, 2022). To prevent VAP, potential infectious sources should be addressed (Pawlik *et al.*, 2022). Moreover, the benefits of the microbiological assessment of specimens obtained using non-invasive methods when selecting an appropriate antimicrobial have not been clearly demonstrated (Garnier *et al.*, 2023). A tracheal aspirate should be requested in patients with suspected or proven VAP who are not taking empirical antibiotics (Kepekci, 2020). The rate of VAP in mechanical ventilation patients was relatively high (Li *et al.*, 2020). These cases can result in prolonged hospitalization, increased costs, and declining moral and legal criticisms (Battaglini *et al.*, 2023b). Inappropriate management, frequent diagnostic errors, overuse of antibiotics, and lack of preventive strategies expose more patients to iatrogenic complications (Rosenthal *et al.*, 2023).

Barotrauma

Barotrauma has been described for many years and is based on the injury that any excessive airway pressure during mechanical ventilation can cause in the lung (McGuinness *et al.*, 2020). The high energy delivered as a transmural pressure gradient can force the liquid from the lumen of the alveoli to the interstitial tissue and eventually to the pleural space (Rajdev *et al.*, 2021). A secondary mechanism for barotrauma is the increase in transpulmonary pressure that can directly overcome the yield of the fibroblastic structure of the lung and result in the rupture of the lung (Alkhatib, 2024). Poorly distensible areas do not rupture under increased localized pressure because the ability of the lung to distribute stress protects the alveoli, but under very high pressure they eventually burst as the pressure in the alveoli is greater than their resistance and the average pressure decreases as the neighboring units fall in collapse (Guven *et al.*, 2021). The clinical manifestations of barotrauma might follow the same clinical presentation of ventilator-associated pneumonia except for hemodynamic instability and frequent cardiovascular collapse (Lodhia *et al.*, 2023). During controlled mechanical ventilation, total barotrauma can result in either pneumothorax or bronchial disruption, while localized barotrauma induced in certain alveoli can result in pneumomediastinum (Mudhar *et al.*, 2022). Emphysematous patients with limited lung-to-pleural adhesion can develop subcutaneous emphysema. Long-term complications including interstitial emphysema, bronchopleural fistula, bronchiectasis, and chronic empyema may occur (Teo *et al.*, 2023). Shallow alveolar recruitment with low VILI ratios may also act as a thrombogenetic factor. The above might indicate that pneumonia can be associated with VAP and barotrauma at the same time (Dogrul *et al.*, 2020).

Current Research and Future Directions

The overall interest in research and future directions in the clinical management of pneumonia related to mechanical ventilation is gradually increasing (Sharma *et al.*, 2021). Furthermore, recent studies in this area have highlighted some important findings regarding pneumonia pathophysiology and treatment, including the effect of the proliferative phase of pneumonia on the mechanics and physiology of the respiratory system. In addition, the treatment of pneumonia has been addressed in several high-quality surveys (Karunarathna *et al.*, 2024c). Although continuous progress in ventilatory strategies has been achieved, much remains to be done to improve this often forgotten category of ICU patients; if adequate interest is not paid, their prognosis is often disappointing (Stainer *et al.*, 2021). Different technological innovations in the last year could be an important help towards a new approach to ventilation strategy for this category of patients (Alafif *et al.*, 2021; Strathdee *et al.*, 2023).

Similarly, several clinical trials are ongoing, and if they are successful, they could revolutionize the field of pneumonia-related mechanical ventilation (Yang and Shu, 2024). As noted in all statements, the perspective set is the point of view of experts in the field, who are usually members of relevant assemblies (Sánchez-Guijo *et al.*, 2020). As indicated, physicians cannot be expected to be experts in all aspects of medicine or implicitly responsible for the care of diseases. In this spirit, perspectives should be written not only by respiratory experts but also by several professionals who are experts in different categories (Liu *et al.*, 2023). In the ICU, several complications are related to the devices and the presence of the endotracheal tube (Martin-Loeches *et al.*, 2023a). The correct management of the airways, which had to be unofficially ensured for a long time during the pandemic, is again one of the main unresolved issues in our discipline (Cilloniz *et al.*, 2023). From this point of view, future perspectives for research should be directed to this aspect as well (Navarra *et al.*, 2020). If we do not start a multidisciplinary approach to the history of the pneumonia process, we could not allow these patients to reach a functional recuperation adequate to guarantee the same cognitive or work performance that they had prior to infection, even after the acute phase (Investigators *et al.*, 2024). The global interest in pneumonia is also part of the panorama of this history (See *et al.*, 2024).

CONFLICT OF INTEREST

Authors hereby declare that they have no conflict of interest.

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