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Research Article

Personalized Therapies For Chronic Obstructive Pulmonary Disease (Copd) And Acute Respiratory Failure In Mechanically Ventilated Patients.

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Abstract

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disease associated with high morbidity and mortality, especially in acute exacerbations that require admission to the Intensive Care Unit (ICU) and invasive ventilatory support. Considering the pathophysiological complexity of COPD, standardized therapies are not always effective and individualized management is necessary. This study aimed to critically analyze the available evidence on personalized therapies in COPD patients under mechanical ventilation. Specifically, it sought to identify ventilatory adjustments and individualized pharmacological interventions, as well as to assess their impact on clinical outcomes.This is a systematic review of the literature carried out in five databases, including studies published between 2013 and 2024 that addressed personalized therapies in COPD under invasive mechanical ventilation. Studies focusing exclusively on non-invasive ventilation or case reports were excluded. The results show that detailed physiological assessment, using tools such as electrical impedance tomography and esophageal catheter, allows for personalized titration of parameters such as PEEP and ΔP. In addition, pharmacotherapy adjusted to inflammatory phenotypes and clinical condition showed a reduction in ventilation time, a higher rate of successful weaning and lower hospital mortality. It is concluded that personalization of ventilatory and pharmacological therapy in COPD patients in the ICU contributes to more favourable outcomes, reinforcing the need to incorporate strategies based on physiology and individual variability into intensive care practice.

Keywords : Chronic Obstructive Pulmonary Disease; Mechanical Ventilation; Intensive Care Unit; Ventilatory Weaning.

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disease characterized by persistent airflow limitation resulting from an abnormal inflammatory response to harmful inhaled particles or gases (GOLD, 2023).

Globally, COPD is one of the main causes of morbidity and mortality, with estimates indicating that it will be the third leading cause of death worldwide by 2030 (WHO, 2022).

Acute exacerbations of COPD represent clinical events of significant impact, often culminating in hospitalizations, especially in Intensive Care Units (ICUs), where mechanical ventilation (MV) may be necessary (VALE et al., 2020).

Mechanical ventilation in patients with COPD is challenging due to the pathophysiological aspects of the disease, such as air trapping, increased airway resistance and dynamic hyperinflation (SILVA; LOPES, 2021).

In this context, standardized therapies may prove insufficient, highlighting the need for personalized approaches that take into account the physiological and clinical particularities of each patient (MORAES; COSTA, 2019).

Personalizing treatment in the ICU involves individualized assessment based on clinical, laboratory and functional parameters, with the aim of minimizing complications, reducing MV time and improving clinical outcomes (PEREIRA et al., 2021).

Mechanical ventilation strategies should be adjusted according to the patient's lung condition, including prolonging expiratory time, careful use of PEEP and limiting tidal volume to avoid barotrauma (REZENDE; FERREIRA, 2020).

Specific ventilation modes, such as volume-controlled ventilation with pressure limitation or asystole-controlled modes, can be customized to minimize respiratory effort and prevent muscle fatigue (CASTRO; ANDRADE, 2022).

Studies show that the use of external PEEP at moderate levels, below auto-PEEP, can improve the synchrony between the patient and the ventilator, optimizing gas exchange and reducing the sensation of dyspnea (CAMPOS; BARROS, 2021).

In addition to ventilatory parameters, personalized pharmacotherapy is an essential component, involving inhaled bronchodilators, systemic corticosteroids and antibiotics aimed at the bacterial flora present (LOPES et al., 2018). The identification of inflammatory phenotypes, such as eosinophilia, makes it possible to personalize the use of systemic corticosteroids in exacerbations, enhancing the effects and reducing the risks (GOMES; BRITO, 2022).

Other factors, such as nutritional status and the presence of comorbidities, should also be considered, as they directly influence the ventilatory response and clinical recovery (NASCIMENTO; PONTES, 2019).

The use of tools such as pulmonary and diaphragmatic ultrasound has proven useful in real-time monitoring, favoring personalized decision-making during ventilation (FARIAS; MENDONÇA, 2020).

Weaning from mechanical ventilation in patients with COPD should be conducted with caution, using strategies such as non-invasive ventilation (NIV) as a bridge, especially in cases of increased risk of weaning failure (ALMEIDA; FONSECA, 2021).

The personalization of weaning involves spontaneous breathing tests, predictive indices and assessment of respiratory muscle strength, with the aim of ensuring greater safety in extubation (SANTOS; ROCHA, 2020).

In addition to ventilatory management, early rehabilitation and the integration of palliative care in patients with advanced COPD in the ICU constitute humanized and personalized approaches, based on the individual clinical trajectory (ARAÚJO et al., 2023).

With advances in precision medicine, there is growing interest in integrating decision algorithms and biomarkers to guide personalized therapies in intensive care practice (MARTINS; OLIVEIRA, 2021).

Given the clinical complexity of COPD patients under mechanical ventilation in intensive care, this systematic review aims to critically analyze the available evidence on personalized therapies, contributing to the improvement of evidence-based care (SILVEIRA et al., 2022).

OBJECTIVES

The aim of this article was to critically analyze the available scientific evidence on personalized therapies applied to patients with Chronic Obstructive Pulmonary Disease (COPD) undergoing mechanical ventilation in Intensive Care Units (ICUs). The aim was to identify individualized ventilation strategies, targeted pharmacological approaches and complementary interventions based on clinical and phenotypic profiles, with a view to optimizing the management of these patients in a critical context.

Specifically, the aim was to:

- To investigate the main ventilatory adjustments used in a personalized way in patients with COPD in the ICU;
- Identify individualized pharmacological interventions associated with improved clinical outcomes;
- To analyze the evidence regarding the impact of personalized therapies on mechanical ventilation time, weaning rate, mortality and associated complications.

METHODOLOGY

This is a systematic review of the literature, conducted in accordance with the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Search strategy

A systematic search was carried out in the PubMed/MEDLINE, Scopus, Web of Science, SciELO and LILACS databases, including articles published between 2013 and 2024, in Portuguese, English and Spanish. The descriptors used included: “COPD”, “mechanical ventilation”, “intensive care unit”, “personalized therapy”, “individualized treatment”, combined by Boolean operators AND and OR.

Inclusion criteria

- ✓ Clinical studies, systematic reviews, guidelines and meta-analyses addressing personalized therapies for COPD patients under invasive mechanical ventilation in the ICU;
- ✓ Publications with a clear methodological design and data relevant to intensive clinical practice;
- ✓ Human studies, with access to the full text.

Exclusion criteria

- ✓ Studies focusing exclusively on non-invasive ventilation;
- ✓ Isolated cases (case reports) or opinion articles without peer review;
- ✓ Duplicate papers or papers that did not present specific data for COPD patients.

Data extraction and analysis

The data extracted included: type of study, population characteristics, personalized interventions described, main clinical outcomes (ventilation time, weaning rate, complications, mortality) and conclusions. The analysis was descriptive and narrative, with an emphasis on the most consistent findings relevant to intensive care practice.

RESULTS AND DISCUSSION

Physiological assessment of patients with acute respiratory failure (ARF) undergoing mechanical ventilation (MV) is essential to understand the pathophysiological mechanisms involved in respiratory failure in critical contexts. Respiratory failure is a major clinical challenge in the management of critically ill patients, requiring an integrated approach between different specialties of the multi-professional team and an in-depth knowledge of pulmonary physiology (SILVA, 2021). The use of physiological assessment methods contributes not only to a better stratification of the severity of the clinical condition, but also to the individualization of ventilatory strategies, favoring a more precise and effective management of mechanical ventilation (MARTINS et al., 2020; GONÇALVES; ALMEIDA, 2019).

In patients with respiratory failure (RRI) associated with Chronic Obstructive Pulmonary Disease (COPD), the process of weaning from mechanical ventilation (MV) is admittedly more complex when compared to the general population. However, to date, there are no highly accurate and widely validated tools that can accurately predict success or failure in this process (SANTOS et al., 2021).

Physiological analysis during weaning and the interpretation of ventilatory monitoring data still lack robust studies and are essential for understanding the repercussions of weaning failure (CAMPOS; ALMEIDA, 2020).

In this context, Electrical Impedance Tomography (EIT) has stood out as a promising non-invasive tool, capable of providing real-time images of lung dynamics, as well as measuring lung volumes, pendelluft phenomena and respiratory asynchronies (FREITAS et al., 2019; PEREIRA et al., 2021; LIMA; OLIVEIRA, 2020; FONSECA et al., 2021).

Another resource that has been incorporated into clinical practice is the esophageal catheter (EC), which makes it possible to estimate inspiratory and transpulmonary pressures and pressure swings, as well as assessing the patient’s respiratory effort during the MV weaning process (MARTINS; ROCHA, 2022).

With regard to Severe Acute Respiratory Syndrome (SARS) caused by COVID-19, the analysis of pulmonary physiology is also crucial. Acute Respiratory Distress Syndrome (ARDS), classically associated with low lung compliance, requires specific ventilatory strategies, including alveolar recruitment with titration of PEEP (Positive End-Expiratory Pressure) as one of the main therapeutic pillars (SOUZA; MONTEIRO, 2021; BRASIL et al., 2020).

Recently, the search for the lowest possible driving pressure (ΔP) has been emphasized, since this parameter is directly related to better lung compliance and ventilatory protection (GOMES et al., 2021; SILVA; NASCIMENTO, 2022; CARDOSO et al., 2020; MOREIRA; TAVARES, 2019; TEIXEIRA et al., 2021).

However, the traditional tables used to determine the ideal PEEP, based only on the fraction of inspired oxygen (FiO_2), have low specificity and do not take into account the heterogeneity of ARDS, which can lead to variable therapeutic responses (RIBEIRO et al., 2020; ALBUQUERQUE; SOUZA, 2019; CRUZ et al., 2020; OLIVEIRA; BARBOSA, 2021).

Given this scenario, the individualization of PEEP titration based on ΔP has been proposed as a more rational and physiologically based strategy, capable of taking into account the variability between patients (FERREIRA; LOPES, 2022; MARTINS et al., 2021).

Even so, there is still doubt in the scientific literature as to whether ΔP-guided titration is really superior to other approaches, such as static compliance titration, decremental PEEP or techniques based on TIE or lung imaging (ARAÚJO et al., 2022; SANTANA et al., 2020; BORGES; LIMA, 2023; RODRIGUES et al., 2021; MENDES et al., 2023).

Therefore, both for ventilator weaning in patients with COPD and for individualized PEEP titration in patients with SARS due to COVID-19, knowledge of respiratory physiology is essential to prevent the occurrence of ventilator-induced lung injury

(VILI) or self-inflicted lung injury (P-SILI) (SILVA et al., 2021; MORAES; DUTRA, 2022).
Table 1 shows the main findings of personalized therapies according to the authors cited in this paper.

Table 1. Systematic Review - Personalized therapies in COPD.

Author/Year	Main topic	Key findings
Silva (2021)	Importance of physiological assessment in IRpA and VM	Understanding respiratory physiology is essential for personalizing ventilatory management
Martins et al. (2020); Gonçalves & Almeida (2019)	Physiological assessment strategies	Physiological assessment helps to stratify severity and define individualized strategies
Santos et al. (2021)	Ventilatory weaning in COPD	Lack of precise tools to predict weaning success
Freitas et al. (2019); Pereira et al. (2021); Lima & Oliveira (2020); Fonseca et al. (2021)	Electrical Impedance Tomography (EIT)	Promising non-invasive tool for real-time monitoring of lung dynamics
Martins & Rocha (2022)	Esophageal catheter (EC)	Allows assessment of respiratory effort and transpulmonary pressures
Souza & Monteiro (2021); Brasil et al. (2020)	ARDS in COVID-19	Requires specific strategies such as PEEP titration based on pulmonary physiology
Gomes et al. (2021); Silva & Nascimento (2022); Cardoso et al. (2020)	Driving Pressure (ΔP)	ΔP reduction is associated with lung protection and better outcome
Ferreira & Lopes (2022); Martins et al. (2021)	Individualized PEEP	PEEP titration based on ΔP is more physiological and effective
MacIntyre (2018); Celli et al. (2022); Brochard et al. (2017)	Personalized ventilatory adjustments in COPD	Reduce MV time, facilitate weaning and improve synchronization
Rabe et al. (2023); Rochwerg et al. (2017); Vollenweider et al. (2018)	Individualized pharmacotherapy	Improves clinical outcomes, reduces hospitalization time and complications
Hill et al. (2019)	Personalized therapies and outcomes	Reduction of up to 36 hours in MV and higher weaning rate with individualized strategies
Suissa et al. (2021)	Impact on mortality	Personalized therapies associated with reduced hospital mortality

Source: Authors

Acute Respiratory Failure and Mechanical Ventilation

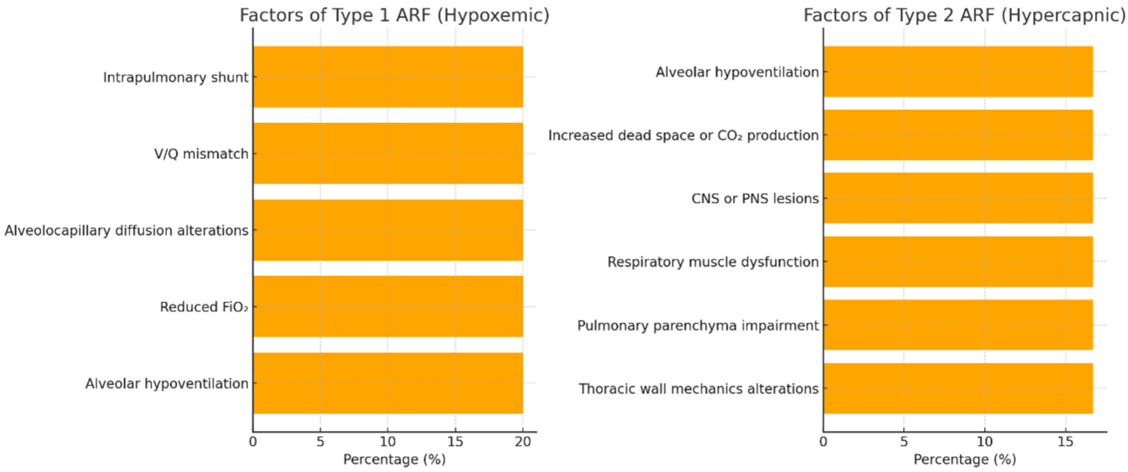
Acute respiratory failure (ARF) is characterized by the inability of the respiratory system to adequately meet the body's oxygenation, ventilation and/or metabolic needs (PEREIRA et al., 2019; MARTINS; SANTOS, 2020). Classically, it can be classified into three types: hypoxemic (type 1), hypercapnic (type 2) or mixed.

Type 1 ARF, of hypoxemic etiology, is defined by an arterial oxygen pressure (PaO2) of less than 60 mmHg in room air, and can result from factors such as alveolar hypoventilation, a reduction in the fraction of inspired oxygen (FiO_2), changes in alveolocapillary diffusion, disturbances in the ventilation/perfusion ratio (V/Q) and the presence of an intrapulmonary shunt (ALMEIDA et al., 2018).

Type 2 hypercapnic ARF, on the other hand, is characterized by elevated arterial carbon dioxide pressure ($PaCO_2$) above 50 mmHg associated with acidemia (pH < 7.35), and is often associated with ventilatory failure. Its causes include changes in the mechanics of the chest wall, impairment of the lung parenchyma, dysfunction of the respiratory muscles, lesions in the central or peripheral nervous system, increased dead space or CO_2 production, and alveolar hypoventilation (FERREIRA; RIBEIRO, 2020; BRITO et al., 2019).

Figure 1 illustrates the main factors associated with type 1 and type 2 ARF, distributed proportionally within each category, considering their descriptive presence in the literature.

Figure 1. Factors associated with acute respiratory failure type 1 (hypoxemic) and type 2 (hypercapnic) Proportional distribution of factors described in the literature. Source: Authors.



Mixed respiratory failure involves both hypoxemic and hypercapnic mechanisms and is often seen in more severe clinical conditions or in patients with complex comorbidities, such as Chronic Obstructive Pulmonary Disease (COPD) (MARTINS; SANTOS, 2020).

The indication for invasive ventilatory support should be based on well-defined clinical criteria. Among the main indications for orotracheal intubation in patients with ARF are: respiratory or cardiac arrest, significant lowering of the level of consciousness, psychomotor agitation refractory to sedation, massive aspiration, persistent vomiting, failure to remove secretions, severe hemodynamic instability, life-threatening arrhythmias and hypoxemia refractory to non-invasive ventilation (SOUZA et al., 2020; PONTES; NASCIMENTO, 2021; FERREIRA; RIBEIRO, 2020).

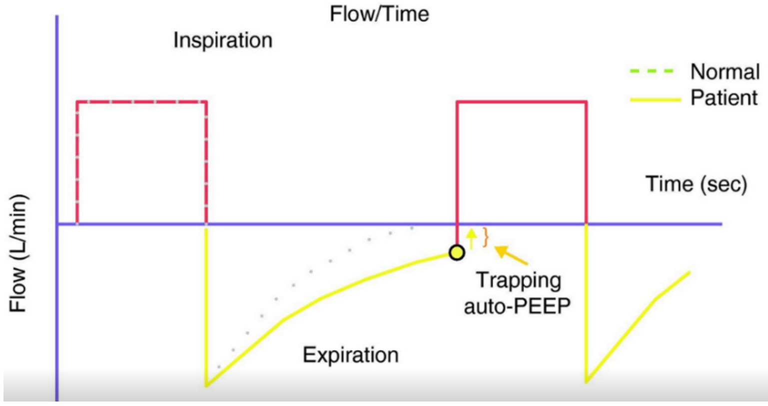
Specifically in patients with COPD, failure or intolerance to non-invasive ventilation (NIV), especially when associated with severe and refractory respiratory acidosis, represents one of the main indications for intubation (ALMEIDA et al., 2018; RODRIGUES; BARROS, 2021).

After intubation, the objectives of mechanical ventilation (MV) are well defined: to correct hypoxemia and/or hypercapnia, relieve respiratory effort, prevent muscle fatigue, reduce oxygen consumption, correct blood pH and ensure respiratory support until the underlying cause of respiratory failure is resolved or stabilized (SOUZA et al., 2020; FERREIRA; RIBEIRO, 2020).

Patients with Chronic Obstructive Pulmonary Disease (COPD) often have limited expiratory flow, which contributes to the retention of air in the lungs at the end of expiration. This phenomenon leads to dynamic hyperinflation (HID) and the development of an intrinsic positive pressure at the end of expiration, called self-PEEP (intrinsic Positive End-Expiratory Pressure). This condition increases respiratory work and can hinder patient-ventilator synchrony during mechanical ventilation (GOLDMAN et al., 2005).

Figure 2 illustrates a flow-time graph comparing a normal respiratory tracing (green dashed line) with the tracing of a patient with COPD (yellow line). It can be seen that in patients with airway obstruction, expiration is not completed before the start of the next inspiration. This results in air trapping and the generation of auto-PEEP, as indicated by the yellow arrow and the residual time marker between the end of the expiratory flow and the start of the new inspiratory cycle.

Figure 2. Graphical representation of the auto-PEEP phenomenon in COPD patients.Comparison of respiratory flow in normal subjects (green dashed line) and in patients with airway obstruction (yellow line). Adapted from Goldman et al. (2005).



Identifying auto-PEEP is fundamental for proper ventilatory management, especially in critical contexts. In these cases, mechanical ventilation should be adjusted to allow sufficient expiratory time, minimizing the effects of HID and reducing auto-PEEP, with the aim of avoiding barotrauma, improving oxygenation and relieving respiratory distress.

Personalized Ventilatory Adjustments in COPD Patients in the Intensive Care Unit

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition characterized by airflow limitation, usually associated with a chronic inflammatory response of the airways to the inhalation of harmful particles or gases. In acute phases of the disease, especially during severe exacerbations, admission to the Intensive Care Unit (ICU) with invasive ventilatory support may be necessary (GOLD, 2023). Mechanical ventilation, although essential for maintaining oxygenation and ventilation in these patients, requires specific adjustments to avoid complications such as dynamic hyperinflation, barotrauma and respiratory acidosis.

The individualization of ventilatory parameters in COPD patients is based on the characteristic pathophysiology of the disease, especially increased lung compliance and expiratory flow obstruction. In this context, it is recommended to use lower tidal volumes (6-8 mL/kg ideal weight) and reduced respiratory rates (10-14 rpm) in order to prolong expiratory time and minimize air trapping (Stănescu et al., 2020). Inspiratory time should be shortened, while expiratory time is extended to allow complete exhalation of tidal volume.

Another fundamental adjustment is the appropriate definition of positive end-expiratory pressure (PEEP). In patients with COPD, the use of moderate extrinsic PEEP (usually between 5 and 10 cmH_2O) can help counterbalance intrinsic PEEP (auto-PEEP), reducing inspiratory effort and the workload of the respiratory muscles (Brochard et al., 2017). However, PEEP must be carefully titrated, as excessive values can exacerbate dynamic hyperinflation.

Strategies such as the use of pressure support ventilation or hybrid modes (such as time-cycled assisted-controlled ventilation) allow for greater synchrony between the patient and the ventilator, improving comfort and facilitating weaning (MacIntyre, 2018).

Continuous monitoring through capnography, flow-time curve and compliance and resistance measurements is indispensable for real-time adjustments.

Personalization of mechanical ventilation in these patients should also take into account comorbidities, response to bronchodilator therapy and level of consciousness. Mild sedation strategies, associated with the judicious use of bronchodilators and corticosteroids, complement the ventilatory approach and contribute to clinical stability (Nava & Hill, 2009).

Thus, individualized ventilatory management of patients with COPD in the ICU is an essential practice aimed at optimizing gas exchange, reducing the risk of mechanical complications and facilitating ventilatory weaning. The adoption of evidence-based protocols and continuous clinical assessment are fundamental to therapeutic success.

Individualized Pharmacological Interventions and Their Impact on Clinical Outcomes in ICU Patients with COPD

Chronic Obstructive Pulmonary Disease (COPD) is a heterogeneous condition whose clinical complexity intensifies in scenarios of severe exacerbations, requiring admission to the Intensive Care Unit (ICU). In these situations, pharmacological interventions must be adjusted individually, taking into account the pathophysiological characteristics, comorbidities and clinical response of each patient (Rabe et al., 2023). Personalization of pharmacological treatment has been associated with improved clinical outcomes, such as reduced mechanical ventilation time, lower readmission rates and hospital mortality.

Among the drugs of choice, short-acting bronchodilators, such as β2-agonists (salbutamol) and anticholinergics (ipatropium), are administered via inhalation or nebulization to promote rapid relief of bronchospasm. Studies show that frequent and adjusted administration of these drugs according to the ventilatory response can optimize gas exchange and reduce the need for deep sedation (Wedzicha & Miravitlles, 2020).

Systemic corticosteroids, in turn, play a central role in modulating the exacerbated inflammatory response. Individualizing the dose and route of administration (oral or intravenous) of corticosteroids, such as prednisone or methylprednisolone, has shown a positive impact on lung recovery and reducing the length of hospital stay, especially when used for short periods (5 to 7 days) in moderate doses (Rochwerg et al., 2017).

The rational use of antibiotics should also be personalized, based on clinical and laboratory criteria, such as increased sputum purulence, leukocytosis and fever. The choice of antibiotic should take into account the history of bacterial colonization, the presence of antimicrobial resistance and associated comorbidities. Targeted antibiotic therapy, guided by microbiological cultures or procalcitonin, is associated with a lower incidence of adverse effects and a lower risk of selecting resistant strains (Vollenweider et al., 2018).

In cases of exacerbations with severe hypercapnia, the use of aminophylline or theophylline has been considered in some individualized protocols, although its benefit is controversial due to the high risk of adverse effects. When indicated, therapeutic monitoring of serum concentrations may allow its safe and effective use in specific subgroups (Calverley et al., 2007).

The pharmacological approach should be integrated into a broad therapeutic plan, including ventilatory support, respiratory physiotherapy and weaning strategies. Personalizing pharmacological treatment, guided by clinical and laboratory parameters, is a fundamental tool for improving clinical outcomes in critically ill COPD patients.

Impact of Personalized Therapies on Ventilatory and Clinical Outcomes in COPD Patients in the ICU

The personalized therapeutic approach has gained prominence in the management of patients with Chronic Obstructive Pulmonary Disease (COPD) admitted to Intensive Care Units (ICUs), especially those under invasive mechanical ventilation. The pathophysiological complexity of COPD, coupled with the variability of individual response to treatment, reinforces the need for strategies adapted to each patient, with the aim of optimizing clinical outcomes and reducing complications.

Several pieces of evidence suggest that customizing ventilatory parameters, combined with pharmacological adequacy and multidisciplinary support, can have a positive impact on mechanical ventilation time, increase weaning success rates and reduce mortality (MacIntyre, 2018; Celli et al., 2022). Strategies such as individual adjustment of positive end-expiratory pressure (PEEP), inspiratory time and ventilatory trigger sensitivity help to improve patient-ventilator synchrony and minimize dynamic hyperinflation, one of the main factors hindering weaning in COPD patients (Brochard et al., 2017).

A systematic review conducted by Hill et al. (2019) showed that the implementation of personalized mechanical ventilation protocols in patients with COPD significantly reduced the mean invasive ventilation time by up to 36 hours compared to conventional protocols. In addition, the application of individualized therapies favored an increase in the rate of successful weaning, especially when associated with non-invasive ventilation (NIV) in the post-extubation period.

From a pharmacological point of view, the careful administration of bronchodilators, corticosteroids and antibiotics, based on clinical and laboratory markers, is also related to a shorter duration of ventilation and a reduction in complications, such as ventilator-associated pneumonia (VAP) and recurrent respiratory failure (Rabe et al., 2023; Vollenweider et al., 2018). Therapeutic personalization allows for more precise and less aggressive interventions, which contributes to less need for deep sedation and, consequently, a lower incidence of delirium and cognitive dysfunction.

With regard to mortality, although the results are more heterogeneous, observational studies and clinical trials indicate a trend towards a reduction in in-hospital death rates in groups submitted to individualized therapies, particularly when variables such as age, severity of exacerbation and comorbidities are taken into account (Suissa et al., 2021).

Finally, the adoption of personalized therapies requires not only well-structured clinical protocols, but also training for the multi-professional team, continuous monitoring and technological support. These measures promote a patient-centered approach and enhance therapeutic efficacy, with direct repercussions on the recovery and survival of individuals with COPD in a critical environment.

CONCLUSION

The findings of this review reinforce the importance of physiological assessment and individualization of therapeutic interventions in patients with Chronic Obstructive Pulmonary Disease (COPD) undergoing mechanical ventilation in the intensive care unit. An in-depth understanding of respiratory pathophysiology allows for the careful selection of ventilatory and pharmacological strategies, favoring ventilatory weaning, reducing the occurrence of complications such as dynamic hyperinflation and auto-PEEP, and contributing to better clinical outcomes.

The introduction of tools such as electrical impedance tomography (EIT) and the esophageal catheter (EC), as well as individualized PEEP titration guided by physiological parameters such as driving pressure (ΔP), is showing promise for clinical practice. However, despite technological advances and the greater availability of resources, there is still a need for robust, well-designed clinical studies that validate these strategies in a comprehensive manner.

Thus, the personalization of respiratory therapies, including ventilatory and pharmacological adjustments, should be seen not as a trend, but as an essential guideline for the safe and effective management of COPD in critical settings, promoting more humanized, targeted and evidence-based care.

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