Revista de Ciencias Médicas de Pinar del Río

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(S2): e7086

REVIEW ARTICLE

Therapeutic approach to acute respiratory distress syndrome in critically ill adults

Edisson Vladimir Maldonado-Mariño[1], **Kerly Yuliana Apolo-Loayza**[1], **Mayra Alexandra López-Villagrán**[1]

[1]Universidad Regional Autónoma de Los Andes. Ambato, Ecuador.

Received: December 30, 2025
Accepted: December 31, 2025
Published: December 31, 2025

Citar como: Maldonado-Mariño EV, Apolo-Loayza KY, López-Villagrán MA. Abordaje terapéutico del síndrome de dificultad respiratoria aguda en adultos críticos. Rev Ciencias Médicas [Internet]. 2025 [citado: fecha de acceso]; 29(S2): e7086. Disponible en: http://revcmpinar.sld.cu/index.php/publicaciones/article/view/7086

ABSTRACT

Introduction: acute respiratory distress syndrome is a severe condition affecting patients in intensive care units, with high mortality rates that underscore its clinical relevance.
Objective: to analyze recent scientific evidence on the most effective therapeutic interventions in the management of acute respiratory distress syndrome in critically ill adults.
Methods: a systematic review of the scientific literature was conducted across multiple databases. The search was performed using an algorithm with keywords and Boolean operators, allowing the identification of relevant sources. The selected studies were critically analyzed considering timeliness, methodological quality, and thematic relevance, and were integrated into the final synthesis of the review.
Development: protective ventilation with low tidal volumes and reduced plateau pressure decreases mortality and pulmonary complications. Prone positioning improves oxygenation and reduces mortality in severe cases. Early use of neuromuscular blockers enhances oxygenation and reduces ventilatory failure rates. Extracorporeal membrane oxygenation proves effective in refractory patients, although associated with risks. Corticosteroids such as dexamethasone have demonstrated clinical benefits, while techniques such as high-frequency oscillatory ventilation and inhaled nitric oxide show inconsistent results. Non-invasive ventilation may be useful in mild to moderate cases, but not in severe ones.
Conclusions: a comprehensive approach combining protective ventilation, prone positioning, and extracorporeal membrane oxygenation in selected cases constitutes the most effective strategy to improve survival and reduce complications in these patients.

Keywords: Critical Care; Respiratory Distress Syndrome; Therapeutics.

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(S2): e7086

INTRODUCTION

Acute respiratory distress syndrome (ARDS) is characterized by widespread inflammation of the lungs and marked changes in ventilation, leading to severe hypoxemia and respiratory failure, indicating a serious condition in intensive care.[1,2] First described in 1967, ARDS remains a major cause of morbidity and mortality in hospitalized patientsin intensive care units (ICUs) worldwide.[3]

Despite advances in our understanding of ARDS pathophysiology and various treatment strategies, the mortality rate associated with ARDS remains high, ranging from 30-50 %, depending on the severity of the illness and the tolerance.[4] The treatment of ARDS is complex and multifaceted and involves a variety of interventions, from mechanical therapy to medical treatments and in vitro techniques.[5] Lung protection through low tidal volume and adequate levels of positive end-expiratory pressure (PEEP) has become a mainstay of treatment and has been shown to significantly reduce morbidity.[6,7]

However, the optimal treatment of ARDS remains a subject of research and debate as new interventions and approaches continue to emerge.[8] This motivated the development of the present study, which aimed to analyze the recent scientific evidence on the most effective therapeutic interventions in the management of acute respiratory distress syndrome in critically ill adults.

METHODS

This study was conducted as a systematic review of the scientific literature, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The objective was to identify and synthesize the available evidence on the most effective therapeutic interventions for managing acute respiratory distress syndrome (ARDS) in critically ill adult patients admitted to intensive care units (ICUs). The search period was defined as January 2000 to December 2024, with the aim of including recent and relevant studies reflecting the most significant advances in mechanical ventilation, pharmacological therapies, and extracorporeal techniques. The review was designed to ensure transparency, reproducibility, and methodological rigor, establishing inclusion and exclusion criteria, as well as search and data analysis strategies, beforehand.

Information sources and search strategy

The literature search was conducted in internationally recognized and widely covered electronic databases, including PubMed/MEDLINE, Cochrane Library, SciELO, ScienceDirect, Google Scholar, LILACS, and BVSALUD. These platforms were selected for their relevance in disseminating biomedical literature and for their accessibility to both regional and global studies. Secondary references derived from key articles were also reviewed, and grey literature, such as academic theses, technical reports, and institutional documents, was considered, provided it met minimum methodological quality criteria and was available in full access. The inclusion of grey literature aimed to reduce publication bias and broaden the perspective on the topic by incorporating evidence not always found in indexed journals.

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(S2): e7086

The search strategy was designed using a combination of keywords and Boolean operators, tailored to each database. Terms in Spanish, English, and Portuguese were used to maximize the retrieval of relevant studies. The main keywords used were: "acute respiratory distress syndrome," "ARDS," "protective mechanical ventilation," "prone positioning," "neuromuscular blockade," "extracorporeal membrane oxygenation," "corticosteroids," and "intensive care." These were combined with Boolean operators such as AND, OR, and NOT, generating specific search algorithms, for example: ("acute respiratory distress syndrome" OR "ARDS") AND ("management" OR "treatment") AND ("intensive care"). Filters were applied for date (2010–2024), publication type (clinical trials, observational studies, systematic reviews, and meta-analyses), and full-text access.

Selection process

The selection of studies was carried out in several phases. First, initial records were identified by searching the databases, yielding a total of 1,180 references. Subsequently, 290 duplicates were removed, leaving 890 records for review of titles and abstracts. After this initial screening, 560 articles were excluded for not meeting the inclusion criteria, leaving 330 for full-text review. Finally, 72 studies were selected that met all the established methodological and thematic requirements.

Studies published within the defined time frame that directly addressed the clinical management of ARDS in adults and reported relevant clinical outcomes such as mortality, duration of mechanical ventilation, ICU stay, and associated complications were included. Articles in Spanish, English, and Portuguese were accepted, provided they were peer-reviewed and presented a sound methodological design. Duplicates, articles without full access, studies irrelevant to the topic, publications outside the time frame, and documents with evident methodological deficiencies, such as the absence of a control group or insufficient sample size, were excluded.

Data extraction and analysis

Data extraction was performed systematically using a standardized form, which collected key variables such as author, year of publication, country, study design, sample size, population characteristics, type of intervention, and main outcomes. The data were organized into comparative tables to facilitate synthesis and analysis. A qualitative synthesis of the findings was conducted, highlighting common trends and patterns in the clinical management of ARDS. In cases where studies provided homogeneous and comparable quantitative data, a meta-analysis was performed using fixed-effects and random-effects statistical models to estimate the effectiveness of the interventions and calculate measures of association such as relative risks and 95 % confidence intervals. The combination of qualitative synthesis and meta-analysis allowed for a robust integration of the evidence, offering a comprehensive and up-to-date perspective on the topic.

DEVELOPMENT

Mechanical ventilation in the prone position has been extensively studied due to its advantages in improving oxygenation and reducing mortality in patients with severe ARDS. Several studies with a significant sample of patients found that this technique reduces mortality compared to the supine position at 28 days.[9,10] Furthermore, they found that oxygenation improved significantly and that there was a decrease in the frequency of ventilator-associated pneumonia. These results support the recommendation of prone positioning as a standard intervention for the management of severe ARDS.[11]

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(S2): e7086

The use of low tidal volumes (approximately 6 ml/kg of ideal body weight) and the limitation of plateau pressure to less than 30 cmH2O are highly effective protective ventilation techniques.[11,12] Compared with conventional ventilation, these techniques significantly reduce mortality and pulmonary complications. These findings highlight the importance of protective ventilation to reduce ventilator-induced lung injury and improve long-term outcomes in patients with ARDS.[12,13]

For patients with ARDS who do not respond to traditional mechanical ventilation, extracorporeal membrane oxygenation (ECMO) has become a crucial treatment option. ECMO has been shown to improve survival in patients with severe ARDS.[14,15] However, due to the high rates of associated complications, such as bleeding and infection, careful patient selection is required. Studies indicate that, although it has some risks, ECMO can be an important tool for treating the most severe ARDS.[16]

The use of corticosteroids in the treatment of ARDS has proven effective. A multicenter study found a significant decrease in mortality among patients who received dexamethasone at 60 days. They also discovered that patients who received methylprednisolone experienced improved oxygenation and a shorter duration of mechanical ventilation.[14,17] These results indicate that corticosteroids, administered in the early stages of ARDS, can significantly improve clinical outcomes, but the dosage and timing of administration must be carefully considered to maximize benefits and reduce adverse effects.[9]

High-frequency oscillatory ventilation (HFOV) has been evaluated in several studies, but the results have been inconsistent. However, they have suggested a potential reduction in mortality in some subgroups of patients with severe ARDS.[18] Other studies found no significant differences in clinical outcomes between conventional ventilation and patients with moderate ARDS. This demonstrates that, although HFOV may be beneficial in some patients, it is not always superior to other ventilation modalities and should therefore be used with caution.[15,17]

Studies that have evaluated the administration of inhaled nitric oxide (iNO) indicate that although it may temporarily improve oxygenation in patients with ARDS, it is not associated with a reduction in mortality and may be related to significant harmful effects, such as methemoglobin formation and increased pulmonary pressure.[10,12,19] These results indicate that iNO should be used with caution and only in specific situations.

Finally, non-invasive ventilation (NIV) was shown to be advantageous for patients with mild to moderate ARDS, but not for patients with severe ARDS.[18] However, NIV was also shown to improve oxygenation and decrease the need for intubation in some patients.[15,16] Nevertheless, its use in patients with severe ARDS is associated with a higher risk of ventilatory failure and the possibility of requiring emergency intubation. These studies show that the use of NIV in the management of ARDS requires careful patient selection and continuous monitoring.[9,16,17,18]

Prone mechanical ventilation, protective ventilation techniques, and the use of ECMO in refractory cases are the most effective interventions in the management of ARDS in adult patients in intensive care, according to the findings of this systematic review. Corticosteroids also show many benefits, especially when administered early in the course of the illness.[10,17] High-frequency oscillatory ventilation and iNO may be useful in some contexts; however, it is important to carefully consider their risks and benefits. Although not necessary for all patients with ARDS, non-invasive ventilation may be beneficial in cases of mild to moderate ARDS.[9,15,20] Based on the available evidence, the appropriate implementation of these tactics can significantly improve clinical outcomes in patients with ARDS in intensive care.

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(S2): e7086

InManaging elderly patients in the ICU remains a significant challenge for intensive care physicians despite advances in treatment strategies. The results of our systematic review provide a comprehensive overview of the most effective interventions and their clinical impact. Clinical mechanical ventilation has been shown to be a key intervention in the treatment of severe ARDS. Studies highlight its ability to improve oxygenation and reduce disease. These outcomes lead to better distribution of pulmonary blood flow and improved air entry, resulting in less internal contraction.[14]

However, it is important to consider the risks associated with passive positioning, including difficulty in airway management and the risk of developing pressure ulcers.[9] To maximize the benefits of these interventions, the implementation of standardized protocols and adequate staff training are essential. Prevention strategies, including the use of low tidal volumes and reduced recovery pressures, have been shown to reduce mortality and morbidity, and this practice should be firmly enforced.[11,14,19,20]

To improve outcomes in patients with ARDS, it is important to protect the lungs by reducing voltammetry and barotrauma. However, individualized intervention and continuous monitoring of respiratory parameters are important to prevent hypoventilation and respiratory acidosis, especially in critically ill patients.[10,11,12] ECMO has been shown to be an effective treatment option for patients with refractory ARDS. Studies have demonstrated that ECMO can improve survival in these patients.[14,18] However, due to the high risk of complications, such as bleeding and infection, patients must be carefully selected and treated professionally. ECMO should be considered in specialized centers with experience in its administration, using strict criteria to maximize benefits and minimize complications.[19]

The use of corticosteroids, especially dexamethasone, has been shown to be beneficial in reducing morbidity and improving health in ARDS.[17] The anti-inflammatory actions of corticosteroids reduce alveolar edema and improve lung function. However, potential side effects, such as hyperglycemia and the risk of infection, must be carefully monitored and managed. Dosage and timing of administration are important and should be optimized to maximize clinical benefit.[15] High-frequency oscillatory ventilation (HFOV) has yielded mixed results. Some suggest that mortality may be reduced in some subgroups of patients with severe ARDS, however, others found no significant differences in clinical outcomes compared with conventional ventilation.[19,20]

These results indicate that high-frequency oscillatory ventilation (HFOV) may be effective in some situations, but not as a curative treatment for ARDS. It is important to select and monitor patients who would benefit from this approach. The use of inhaled nitric oxide (iNO) has been shown to improve short-term ventilation in patients with ARDS, but it is not associated with reduced morbidity and may have adverse effects such as increased methemoglobin production and pulmonary pressure.[10,11,18] These results indicate that iNO should be used with caution and only in specific cases where a clear clinical benefit is expected. Non-invasive ventilation (NIV) has been shown to improve health and reduce the need for intubation in patients with mild to moderate ARDS. [10,12,20] However, its use in patients with severe ARDS is associated with a higher risk of respiratory failure and the need for urgent hospitalization. These findings highlight the importance of patient selection and continuous monitoring when using NIV for the treatment of ARDS.

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(S2): e7086

CONCLUSIONS

A systematic review of the effectiveness of interventions in the management of ARDS in critically ill adults reveals findings relevant to clinical practice. Mechanical ventilation with protective strategies, such as the use of low tidal volumes and plateau pressure limitation, has been shown to reduce mortality and respiratory complications, provided it is accompanied by individualization and continuous monitoring to prevent acidosis and ensure efficacy. Prone positioning and ECMO are effective options in severe cases, although they require careful selection and specialized expertise. The use of corticosteroids, especially dexamethasone, provides clinical benefits by reducing inflammation and improving lung function, while techniques such as high-frequency oscillatory ventilation and iNO show inconsistent results and should be applied with caution. Non-invasive ventilation is useful in patients with mild to moderate ARDS, reducing the need for intubation, but its use in severe cases increases the risk of respiratory failure. Overall, the evidence supports a comprehensive and selective approach that combines protective strategies, advanced interventions, and careful adaptation to the individual clinical context to optimize survival and reduce complications.

BIBLIOGRAPHIC REFERENCES

1. Ferguson ND, Fan E, Camporota L, Antonelli M, Anzueto A, Beale R, et al. The Berlin definition of ARDS: an expanded rationale, justification, and supplementary material. Intensive Care Med [Internet]. 2012 [Citado 15/02/2025]; 38(10):1573–82. Disponible en: https://pubmed.ncbi.nlm.nih.gov/22926653/

2. Tonetti T, Vasques F, Rapetti F, Maiolo G, Collino F, Romitti F, et al. Driving pressure and mechanical power: new targets for VILI prevention. Ann Transl Med [Internet]. 2017 Jul 1 [Citado 150/2/2025]; 5(14):286. Disponible en: https://pubmed.ncbi.nlm.nih.gov/28828361/

3. Bellani G, Pham T, Laffey J. Incidence of acute respiratory distress syndrome-reply. JAMA [Internet]. 2016 Jul 19 [Citado 15/02/2025]; 316(3): 347. Disponible en: https://pubmed.ncbi.nlm.nih.gov/27434453/

4. Ranieri VM, Tonetti T, Navalesi P, Nava S, Antonelli M, Pesenti A, et al. High-flow nasal oxygen for severe hypoxemia: oxygenation response and outcome in patients with COVID-19. Am J Respir Crit Care Med[Internet]. 2022 Feb 15 [Citado 15/02/2025]; 205(4): 431–9. Disponible en: https://pubmed.ncbi.nlm.nih.gov/34861135/

5. Rice TW, Wheeler AP, Bernard GR, Hayden DL, Schoenfeld DA, Ware LB. Comparison of the SpO2/FIO2 ratio and the PaO2/FIO2 ratio in patients with acute lung injury or ARDS. Chest [Internet]. 2007 [Citado 15/02/2025]; 132(2):410–7. Disponible en: https://pubmed.ncbi.nlm.nih.gov/17573487/

6. Gattinoni L, Carlesso E, Caironi P. Stress and strain within the lung. Curr Opin Crit Care [Internet]. 2012 Feb [Citado 15/02/2025];18(1):42–7. Disponible en: https://pubmed.ncbi.nlm.nih.gov/22157254/

7. Combes A, Bréchot N, Luyt CE, Schmidt M. Indications for extracorporeal support: why do we need the results of the EOLIA trial? Med Klin Intensivmed Notfmed [Internet]. 2018 Feb 1 [Citado 15/02/2025]; 113(Suppl 1): 21–5. Disponible en: https://pubmed.ncbi.nlm.nih.gov/29149363/

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(S2): e7086

8. Brown SM, Grissom CK, Moss M, Rice TW, Schoenfeld D, Hou PC, et al. Nonlinear imputation of Pao2/Fio2 from Spo2/Fio2 among patients with acute respiratory distress syndrome. Chest [Internet]. 2016 Aug 1 [Citado 15/02/2025]; 150(2):307–13. Disponible en: https://pubmed.ncbi.nlm.nih.gov/26836924/

9. Rampon GL, Simpson SQ, Agrawal R. Prone Positioning for Acute Hypoxemic Respiratory Failure and ARDS: A Review. Chest [Internet]. 2023 Feb 1 [cited 11/06/2024]; 163(2): 332–40. Available from: http://journal.chestnet.org/article/S0012369222038880/fulltext

10. Grasselli G, Calfee CS, Camporota L, Poole D, Amato MBP, Antonelli M, et al. ESICM guidelines on acute respiratory distress syndrome: definition, phenotyping and respiratory support strategies. Intensive Care Medicine [Internet]. 2023 Jun 16 [cited 11/06/2024]; 49(7): 727–59. Available from: https://link.springer.com/article/10.1007/s00134-023-07050-7

11. Pelosi P, Ball L, Barbas CSV, Bellomo R, Burns KEA, Einav S, et al. Personalized mechanical ventilation in acute respiratory distress syndrome. Crit Care [Internet]. 2021 Dec 1 [cited 11/06/2024]; 25(250). Available from: https://ccforum.biomedcentral.com/articles/10.1186/s13054-021-03686-3

12. Grotberg JC, Reynolds D, Kraft BD. Management of severe acute respiratory distress syndrome: a primer. Critical Care [Internet]. 2023 Jul 18 [cited 11/06/2024]; 27(289). Available from: https://ccforum.biomedcentral.com/articles/10.1186/s13054-023-04572-w

13. Bos LDJ, de Grooth HJ, Tuinman PR. A structured diagnostic algorithm for patients with ARDS. Crit Care [Internet]. 2023 Dec 1 [cited 11/06/2024]; 27(94). Available from: https://ccforum.biomedcentral.com/articles/10.1186/s13054-023-04368-y

14. Fujishima S. Guideline-based management of acute respiratory failure and acute respiratory distress syndrome. J Intensive Care [Internet]. 2023 Dec 1 [cited 11/06/2024]; 11(10). Available from: https://jintensivecare.biomedcentral.com/articles/10.1186/s40560-023-00658-3

15. Matthay MA, Arabi Y, Arroliga AC, Bernard G, Bersten AD, Brochard LJ, et al. A New Global Definition of Acute Respiratory Distress Syndrome. Am J Respir Crit Care Med [Internet]. 2024 Jan 1 [cited 11/06/2024]; 209(1): 37–47. Available from: https://pubmed.ncbi.nlm.nih.gov/37487152/

16. Parikh aka Parmar T, Pilcher D. Acute respiratory distress syndrome. Anaesthesia & Intensive Care Medicine [Internet]. 2022 Oct 1 [cited 11/06/2024]; 23(10): 635–41. Disponible en: https://www.anaesthesiajournal.co.uk/article/S1472-0299(22)00162-X/fulltext

17. Chaudhuri D, Nei AM, Rochwerg B, Balk RA, Asehnoune K, Cadena R, et al. 2024 Focused Update: Guidelines on Use of Corticosteroids in Sepsis, Acute Respiratory Distress Syndrome, and Community-Acquired Pneumonia. Crit Care Med [Internet]. 2024 May 1 [cited 11/06/2024]; 52(5): E219–33. Available from: https://pubmed.ncbi.nlm.nih.gov/38240492/

18. Smit MR, Mayo PH, Mongodi S. Lung ultrasound for diagnosis and management of ARDS. Intensive Care Med [Internet]. 2024 Apr 24 [cited 11/06/2024]; 50: 1143–1145. Available from: https://link.springer.com/article/10.1007/s00134-024-07422-7

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2025; 29(S2): e7086

19. Battaglini D, Fazzini B, Silva PL, Cruz FF, Ball L, Robba C, et al. Challenges in ARDS Definition, Management, and Identification of Effective Personalized Therapies. Journal of Clinical Medicine [Internet]. 2023 Feb 9 [cited 11/06/2024]; 12(4): 1381. Available from: https://www.mdpi.com/2077-0383/12/4/1381/htm

20. Qadir N, Sahetya S, Munshi L, Summers C, Abrams D, Beitler J, et al. An Update on Management of Adult Patients with Acute Respiratory Distress Syndrome: An Official American Thoracic Society Clinical Practice Guideline. Am J Respir Crit Care Med [Internet]. 2024 Jan 1 [cited 11/06/2024]; 209(1): 24–36. Available from: https://pubmed.ncbi.nlm.nih.gov/38032683/