J Biochem Technol (2023) 14(1): 80-87
https://doi.org/10.51847/3SKsqBIIPC
ISSN: 0974-2328

# Diagnosis and Management of Acute Respiratory Distress Syndrome: A Systematic Review

**Alaa Esam Ghabashi, Abdulhadi Salem Towairqi*, Manar Abdulsalam Emam, Mashail Hashim Farran, Yahya Abdullah Alayyafi**

Received: 04 December 2022 / Received in revised form: 12 March 2023, Accepted:15 March 2023, Published online: 19 March 2023

## Abstract

A growing number of research on management and diagnostic strategies in respiratory distress syndrome have been undertaken; nevertheless, there is no clear consensus on the prognosis among those patients. The goal of this systematic review was to consolidate current data on the management and diagnosis of patients with respiratory distress syndrome. The authors began by recognizing the important examination proof that spots light on the management and diagnosis of respiratory distress syndrome. We led electronic writing look in the accompanying data sets: Ovid Medline (2015 to present), Ovid Medline Daily Update, Ovid Medline in process and other non-filed references, Ovid Embase (2015 to present), The Cochrane Library (latest issue) and Web of Science. Just examinations in the English language will be incorporated. The precise selection was acted in close collaboration with a clinical examination curator. In all included studies the management was done at ICU and the diagnosis was done through chest x-ray and CT scans. The design was a retrospective study and prospective cohort study. The causes of ARDS varied among studies. Community-acquired pneumonia was the most common cause. One study included infants with ARDS. Other studies included ARDS in COVID-19 patients. The ICU stay length ranged from 11 to 21 days. The death occurred among several patients. ARDS management focuses primarily on supportive care, lung-protective ventilation, and reducing the type of iatrogenic lung injury, and extracorporeal life support is the last resort for patients who continue to deteriorate despite these supportive treatments.

**Keywords:** Respiratory distress syndrome, Community-acquired pneumonia, Intensive care units, Respiratory failure, Pulmonary ventilation

**Alaa Esam Ghabashi**
Adult Critical Care Consultant, King Abdul-Aziz Medical City, Jeddah, Saudi Arabia.

**Abdulhadi Salem Towairqi*, Manar Abdulsalam Emam, Mashail Hashim Farran, Yahya Abdullah Alayyafi**
Adult Critical Care Resident, King Abdul-Aziz Medical City, Jeddah, Saudi Arabia.

***E-mail:** Towairqiab@mngha.med.sa



## Introduction

Unanticipated respiratory horror issue (ARDS) is a possibly lethal kind of respiratory dissatisfaction depicted by serious, certain, burnable lung hurt (Fan *et al*., 2018), which causes broadened alveolar fine weakness and the improvement of non-hydrostatic pneumonic edema. Clinically, ARDS is portrayed by serious hypoxia and respiratory misery; patients regularly advance to respiratory disappointment, requiring conspicuous mechanical ventilation in the crucial idea unit (ICU). The chance of death is great. ARDS can be accomplished by various diseases, including pneumonia, extrapulmonary sepsis or septic shock, injury, and pancreatitis. Despite understanding thoughts on ARDS care (Fan *et al*., 2017; Griffiths *et al*., 2019; Papazian *et al*., 2019), immense generally speaking change in association continues, and proof openings drive forward, strikingly concerning ARDS related with COVID-19 (Ashbaugh *et al*., 1967; Bellani *et al*., 2016). Taking into account late clinical practice proposals, we report on the end and treatment of ARDS for generalist clinicians (Saaty & Aljadani, 2021; Sadeghi *et al*., 2021).

Serious respiratory horror issue (ARDS) was first depicted in 1967 as a clinical condition portrayed by the phenomenal beginning of tachypnea, hypoxemia, and loss of lung consistency because of different updates; the principal portrayal saw that ARDS was not receptive to ordinary and standard respiratory treatment philosophies (Ashbaugh *et al*., 1967; Florina *et al*., 2022). This disease is seen by inescapable lung fuel, which prompts the movement of pneumonic edema. The outrageous season of ARDS is depicted morphologically by far and wide alveolar annihilation (Fan *et al*., 2018). Formal ARDS interesting measures were not widely settled until the American-European Consensus Conference (AECC) in 1994 (Bernard *et al*., 1994). The AECC models coordinate the presence of noncardiogenic, two-sided enters on chest radiographs, as well as the setback of left atrial hypertension. The presence of hypoxemia was evaluated utilizing the degree of vein oxygen halfway strain to part of inhaled new live into oxygen (Pao2/FiO2), with a Pao2/FiO2 of 200 mm Hg pivotal for ARDS confirmation. Two or three issues hampered the AECC definition, including the deficiency of an imparted season of beginning, massive interobserver fluctuation of the chest radiograph, and the necessity for pneumonic course catheterization to hinder left atrial hypertension (Fan *et al*., 2018).

The LUNG SAFE examination found contrasts in the utilization of proof-based drugs for ARDS among European focuses (Bellani *et al.*, 2016). Barely any mediations are kept up with by unprecedented affirmation, yet gigantic forward hops in the association of the burden, broadly in ventilation, have been achieved during the most recent twenty years. These were then coordinated into clinical practice recommendations (Fan *et al.*, 2017; Griffiths *et al.*, 2019; Papazian *et al.*, 2019). **Figure 1** sums up an expected method for managing and directing ARDS patients.

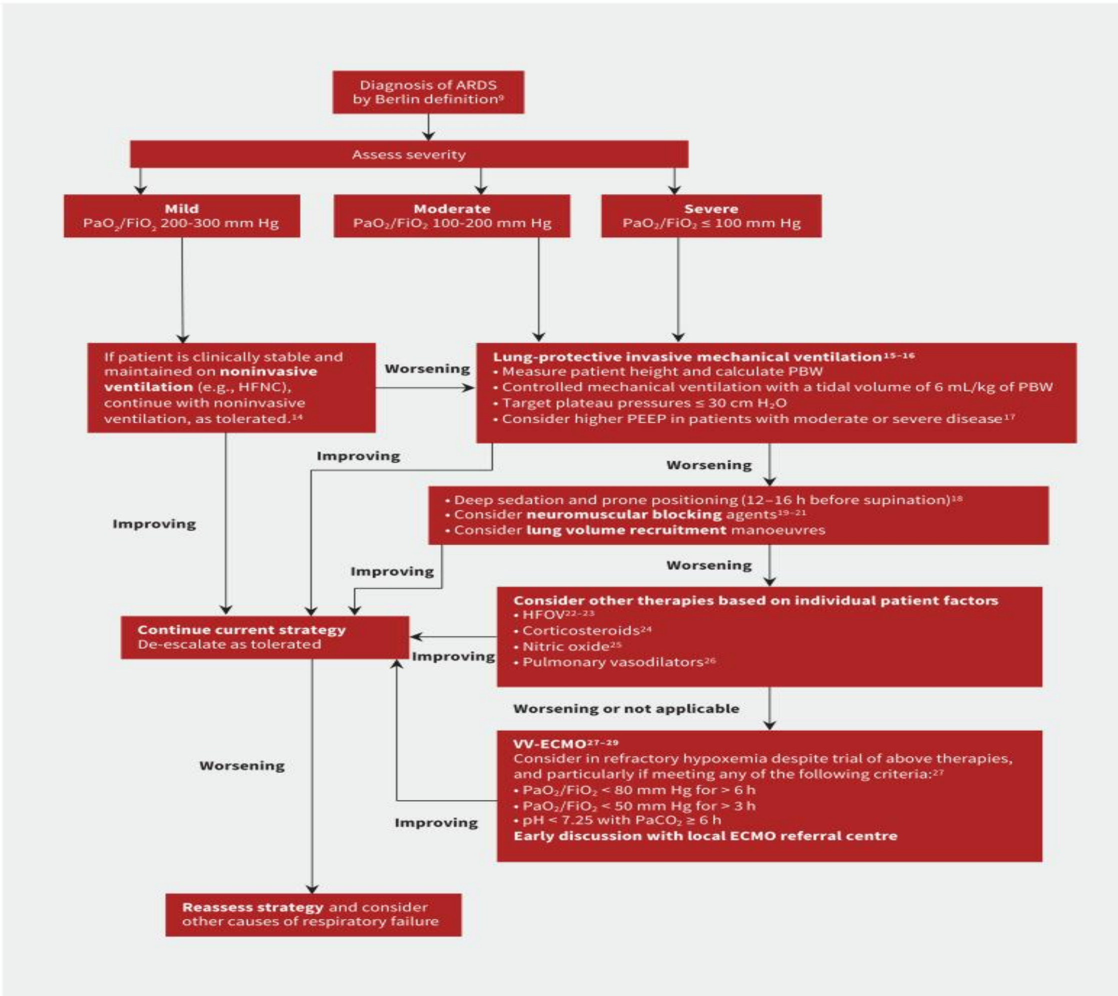


**Figure 1.** Suggested treatment algorithm showing risk stratification and tiered approach to therapy for patients with acute respiratory distress syndrome (ARDS). Note: HFNC = high-flow nasal cannula, HFOV = high-frequency oscillatory ventilation, PEEP = positive end-expiratory pressure, PBW = predicted body weight, VV-ECMO = venovenous extracorporeal membrane oxygenation.

## Materials and Methods

### *Review Question*

This review seeks to spotlight the latest updates on the management and diagnostic methods of acute respiratory distress syndrome. The specific review questions to be addressed are:

1. What are the management approaches for acute respiratory distress syndrome?
2. What are the different diagnostic methods for acute respiratory distress syndrome?
3. What is the outcome of patients with acute respiratory distress syndrome?

### *Searches*

We began with recognizing the important examination proof that spots light on the latest updates on the management and diagnostic methods of acute respiratory distress syndrome. We led electronic writing look in the accompanying data sets: Ovid Medline (2015 to present), Ovid Medline Daily Update, Ovid Medline in process and other non-filed references, Ovid Embase (2015 to present), The Cochrane Library (latest issue) and Web of Science. Just examinations in the English language will be incorporated. The precise selection was acted in close collaboration with a clinical examination curator.

Also, the bibliographies of any qualified articles recognized were checked for extra references, and reference looks were done for all included references utilizing the ISI Web of Knowledge.

We considered "published" articles to be compositions that showed up in peer-reviewed journals. Articles present in grey literature were excluded from our review.

*Types of Studies to be Included*

We included articles covering how to coordinate different review plans in an orderly review of seeks the latest updates on the management and diagnostic methods of acute respiratory distress syndrome. We did exclude articles only depicting the management and outcome of ARDS patients.

We concentrated on the latest updates on the management and diagnostic methods of acute respiratory distress syndrome. We included articles depicting sample sizes and articles that planned to sum up their outcomes to the populace which the test was drawn from. Case series and case reports were excluded from our search. Studies from all areas all over the world were incorporated with a focus on studies from the Kingdom of Saudi Arabia

*Participants*

The systematic review included examinations with tests of the general population who had respiratory distress syndrome or articles discussing the guidelines for the management of respiratory distress syndrome.

*Searching Keywords*

For every data set, looking through was led by utilizing a mix of the accompanying keywords: (respiratory distress OR intensive care unit OR respiratory failure OR mechanical ventilation OR Kingdom of Saudi Arabia OR systematic review).

We included examinations enrolling members in everyone as well as clinical settings. Studies were incorporated assuming they revealed management and diagnostic methods of respiratory distress syndrome. No comparator or control test size is required in the review to be incorporated.

*Studies Selection Process*

All list items were brought into an EndNote record. Two analysts evaluated titles and abstracts for their likely pertinence.

One reviewer freely screened titles and abstracts from the search and any articles that report the management and diagnosis of ARDS among patients. We gained the full text of articles that possibly meet the eligibility criteria.

There was no geographical limit on the included studies. Just published articles in the English language will be incorporated.

*Outcomes*

*Primary Outcome*

To spotlight management strategies and diagnostic methods of respiratory distress syndrome.

*Secondary Outcome*

To evaluate the clinical outcome of patients with respiratory distress syndrome.

*Information Extraction, (Choice and Coding)*

Information was extracted from the included articles utilizing an electronic information extraction structure on Microsoft Access programming. Two reviewers freely extracted information, utilizing a standard information extraction structure that was created by the survey creators with the end goal of the review. The extraction structure incorporated the accompanying data:

1. Publication subtleties: title, authors, journal name and year and city, distribution, the country in which the review was led, sort of distribution, and wellspring of financing.
2. Study subtleties: concentrate on the plan (cross-sectional, cohort, case-control), settings (clinical or population-based), concentrate on transience (planned or review), patients' enlistment techniques (successive or non-continuous), the geographical area, year of information assortment and reaction rate, qualification (consideration and avoidance rules), name of appraisal tool(s), approval of evaluation tool(s).
3. Study members' subtleties: number of people reviewed/examined, population qualities including mean age (SD), gender distribution, relationship status, and demographic data.

*Data Management*

Descriptive statistics are employed and relevant data are extracted from eligible studies and presented in tables. We then presented a narrative synthesis of the summary of the management and diagnosis among ARDS patients.

## Results and Discussion

A total of 2148 studies were identified in the search, all of them were assessed for eligibility, and 43 articles were included in this review **(Figure 2)**. Of the 43 articles, all of them were published journal articles. Studies that were published in peer-reviewed journals were eligible for screening. However, 21 studies were excluded at the beginning of screening because they were published in non-English language. 10 studies were addressing respiratory distress syndrome as a pathophysiology without addressing the management or diagnostic approaches. Furthermore, 4 studies were published in journals not listed in the databases we searched. Finally, 8 studies were included so that authors could extract all required data from abstracts or full texts. There were 5 of these studies in the Kingdom of Saudi Arabia (KSA) and 3 articles in other countries.

In the current analysis, we involved 8 studies. All of them the management was done at ICU (Corrêa *et al*., 2015; Kao *et al*., 2015; Mahmoud *et al*., 2016; Alfarwati *et al*., 2019; Ahmed *et al*., 2020; Aleanizy *et al*., 2021; Alharbi *et al*., 2022; Shi *et al*., 2022) and the diagnosis was done through chest x-ray and CT scans (Corrêa *et al*., 2015; Kao *et al*., 2015; Mahmoud *et al*., 2016; Alfarwati *et al*., 2019; Ahmed *et al*., 2020; Aleanizy *et al*., 2021; Alharbi *et al*., 2022; Shi *et al*., 2022). The design was a retrospective study in studies (Mahmoud *et al*., 2016; Alfarwati *et al*., 2019; Ahmed *et al*., 2020; Aleanizy *et al*., 2021; Alharbi *et al*., 2022; Shi *et al*., 2022) and a prospective cohort study in (Corrêa *et al*., 2015; Kao *et al*., 2015). The causes of ARDS varied among studies. Community-acquired pneumonia was prevalent in (Corrêa *et al*., 2015; Kao *et al*., 2015; Mahmoud *et al*., 2016; Shi *et al*., 2022). One study included infants with ARDS (Alfarwati *et al*., 2019). Other studies (Aleanizy et al., 2021; Alharbi *et al*., 2022) included ARDS in COVID-19 patients. The ICU stay length ranged from 11 to 21 days. Death occurred among several patients as presented in **Table 1**. There were many risk factors identified among patients with ARDS as presented in the forest plot figure **(Figure 3)**.

**Table 1.** Characteristics of studies included in the review

| Author | Year | Country | Design | Population | Sample size | ARDS patients | Cause of ARDS | Management | Hospitalization length | Outcome |
|---|---|---|---|---|---|---|---|---|---|---|
| Mahmoud *et al*. | 2016 | KSA | Retrospective study | Adults | 350 | 350 | Community-acquired pneumonia (339)<br>TB (11) | ICU management | 21.4 days | Death (7) |
| Ahmed *et al*. | 2020 | KSA | Retrospective study | Adults | 68 | 38 | H1N1 infection (13)<br>Fibrosis (13)<br>Pneumonia (12) | ICU management | - | Death (29) |
| Alfarwati *et al*. | 2019 | KSA | Retrospective study | Infants | 59 | 59 | Low birth weight<br>Cesarean section<br>Premature rupture of membranes | Neonatal ICU management | - | Death (3) |
| Alharbi *et al*. | 2022 | KSA | Retrospective study | Adults with COVID-19 | 809 | 255 | COVID-19 | ICU management | 11.1 days | Death (64) |
| Aleanizy *et al*. | 2021 | KSA | Retrospective study | Adults with COVID-19 | 1026 | 103 | COVID-19 | ICU management | 20 days | Death (23) |
| Corrêa *et al*. | 2015 | Brazil | Prospective cohort study | Adults with respiratory failure | 462 | 26 | Community-acquired pneumonia (10)<br>Cardiogenic pulmonary edema (4)<br>Acute COPD (8)<br>Others (4) | ICU management | 12 days | death (5) |
| Kao *et al*. | 2015 | Taiwan | Prospective cohort study | Adults | 3002 | 296 | Community-acquired ARDS (70)<br>Hospital-acquired ARDS (83)<br>ICU-acquired ARDS (143) | ICU management | 18 days | Death (155) |
| Shi *et al*. | 2022 | China | Retrospective study | Adults | 529 | 179 | Pneumonia | ICU management | - | - |

**Table 2.** Summary of mechanical ventilation interventions for the acute respiratory distress syndrome (ARDS) and recommendations from the clinical practice guidelines of the American Thoracic Society (ATS), European Society of Intensive Care Medicine (ESICM), Society of Critical Care Medicine (SCCM), Societé de réanimation de langue Française (SRLF) and Intensive Care Society (ICS)

| Intervention | ARDS severit | Rationale | Strength of recommendation | | |
|---|---|---|---|---|---|
| | | | ATS/ESICM/SCCM (Fan *et al*., 2017) | SRLF (Papazian *et al*., 2019) | ICS (Griffiths *et al*., 2019) |
| Low tidal volumes (4–8 mL/kg predicted body weight) | Any | Mechanical ventilation may potentiate acute lung injury, and lower tidal volumes may mitigate VILI | Strong recommendation for routine use | Strong agreement for routine use | Strong recommendation for routine use |

| | | | | | |
|---|---|---|---|---|---|
| Lower inspiratory pressures (plateau pressure < 30 cm $H_2O$) | Any | Increased plateau pressures may contribute to VILI, even with appropriate tidal volumes | Strong recommendation for routine use | Strong agreement for routine use | Strong recommendation for routine use |
| Higher PEEP instead of lower PEEP | Moderate /severe | Higher PEEP may optimize alveolar recruitment, and acts to decrease intrapulmonary shunt and reduce the risk of VILI | Conditional recommendation for routine use | Strong agreement for routine use | Weak recommendation for routine use |
| Prone positioning | Severe | Prone positioning improves lung recruitment, primarily in dependent regions, and therefore increases end-expiratory lung volume, improves ventilation–perfusion matching and decreases VILI | Strong recommendation for routine use (> 12 h per day) | Strong agreement for routine use (in patients with $Pao_2/FiO_2$ < 150 mm Hg; 16 consecutive hours) | Strong recommendation for routine use (> 12 h per day) |
| High-frequency oscillatory ventilation | Moderate /severe | Method of ventilation that provides very small tidal volumes at higher mean airway pressures, therefore minimizing tidal stress and strain | Strong recommendation **against** routine use | Strong agreement **against** routine use | Strong recommendation **agains t** routine use |
| Recruitment manoeuvres | Any | Recruitment manoeuvres (i.e., transient elevations in applied airway pressures) may reduce atelectasis and increase end-expiratory lung volume by opening collapsed alveoli | Conditional recommendation for routine use | Strong agreement **against** routine use | No recommendation on the basis of poor evidence at the time of guideline development |
| VV-ECMO | Severe | Extracorporeal oxygenation and removal of carbon dioxide can replace the function of diseased lungs in ARDS, and allow for minimal ventilator settings to reduce incidence of VILI | No recommendation on the basis of poor evidence at the time of guideline development | Strong agreement for use in severe ARDS with $Pao_2/FiO_2$ < 80 or in cases of refractory hypoxemia | Weak recommendation for use in selected patients |

Note: PEEP = positive end-expiratory pressure, VILI = ventilator-induced lung injury, VV-ECMO = venovenous extracorporeal membrane oxygenation.

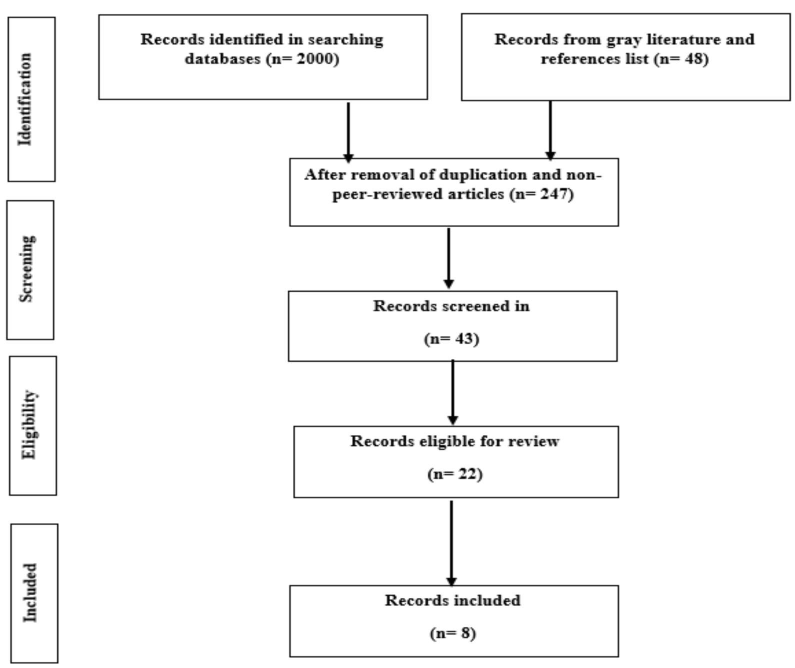


**Figure 2.** Flow chart of the selection process

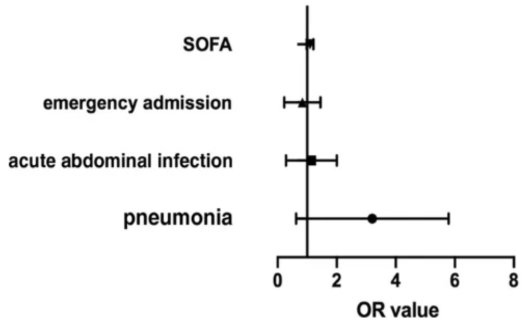


**Figure 3.** Forest plot for risk factors of the severity of ARDS

The Berlin standard was used in the LUNG SAFE Apparant Attendee Assessment to screen ARDS patients from 459 ICUs in 50 countries in five country areas (Bellani *et al*., 2016) 10.4 percent of all ICU clearances were controlled by ARDS, and 23.4 percent of patients required mechanical ventilation in this assessment. Pneumonia, extrapulmonary contamination, target, and injury were the most commonly seen explanations for ARDS. The central duration of mechanical acquisition in patients with ARDS was 8 days (interquartile range 416). Admissions were critical, with 39.6 percent of patients brazenly failing practice, and admissions increased with ARDS authenticity (34.9 percent, 40th3 percent, and 46.1 percent of frail, moderate, and unhealthy weight patients independently making headlines in clinical concentration). Persist and survivors face animal panic (Cochi *et al*., 2016).

ARDS survivors have underlying areas and deficiencies that persist up to 5 years after hospital discharge, resulting in reduced disability and less impairment in physical activity (Herridge *et al*., 2003; Herridge *et al*., 2011). In addition, survivors show a slowdown in the psychological, psychological, and monetary consequences of ARDS (Herridge *et al*., 2011). The preparation for the treatment of ARDS is lung-protective mechanical ventilation. **Table 2** summarizes the proposed clinical rules for mechanical relaxation. The main goal is to limit the ventilation driven by the fan. Lung injury is an iatrogenic form of lung injury that progresses to perturbation and is associated with additional shocking consequences in critically ventilated patients (Slutsky & Ranieri, 2013).

Just as had overcome insane mechanical stress (p. Beast Transmission Volume) converts to an explosive response (i.volutrauma), can spread by spreading and cause frustration in distant organs (e.g. biotrauma). Randomized evaluations have shown that ventilation of ARDS patients with reduced drive volumes corresponding to the expected body weight and loads worked reliably with significantly lower adversity rates (Amato *et al*., 1998; Acute Respiratory Distress Syndrome Network, 2000). Lung-controlled ventilation is given to prevent possible hypercapnia and acidosis, which may persist if sensitive (Acute Respiratory Distress Syndrome Network, 2000).

Existing evidence suggests that the most basic levels of positive end-expiratory tension are observed in patients with moderate to insane ARDS (Bellani *et al*., 2017). Being aware of higher positive end-expiratory tension could reduce repetitive alveolar rupture and associated shear damage in the lungs. Positive end-expiratory tension can affect hemodynamics and cause pulmonary hypertension. This treatment has proven compelling in people with moderate to unresponsive ARDS (Briel *et al*., 2010). Different methods to control the increasing ventilation, e.g. B. oscillating ventilation with high reps, have not become established (Ferguson *et al*., 2013), and considerations have questioned their further use in ARDS patients (Bellani *et al*., 2017). In individuals with moderate ARDS, simple ventilation should be attempted anyway; likely, individuals with more difficult conditions will not help (Bellani *et al*., 2017). In a recent meta-review, high-flow nasal cannula oxygen therapy was shown to limit the need for intubation and mechanical ventilation in patients with incredible hypoxemic respiratory confusion but did not reduce mortality (Rochwerg *et al*., 2019).

In 2020, the COVID-19 pandemic propelled ARDS to the pinnacle of the chart. Improvement in ARDS because of extreme COVID-19 became (and is) normal, and it's far uncertain whether or not COVID-19-associated ARDS contained a reserve fraction of various styles of ARDS and whether or not a restore method distinct became needed (Fan *et al*., 2020). Early revelations (Navas-Blanco & Dudaryk, 2020) cautioned planned non-compulsory remedies for COVID-19-associated ARDS. Two distinct general rankings for ARDS were provided in sufferers with COVID-19: kind H, represented with the aid of using excessive prolongation of suction, excessive air flow/perfusion rate, excessive lung weight, and excessive alveolar recruitment (dependable in traditional extreme ARDS) and kind L, represented with the aid of using unacceptable numbers for relative parts (Gattinoni *et al*., 2020).

A few specialists speculated that maximum sufferers with COVID-19-associated ARDS might before everything gift with kind L characteristics, with a pair converting to kind H, and that clinicians have to keep in mind early intubation in sufferers with kind L ARDS, in addition offering that those sufferers may want to preserve thru better streaming volumes without the threat of ventilator-impelled lung damage (Gattinoni *et al*., 2020; Navas-Blanco & Dudaryk, 2020).

Be that because it might also add, popular stress or volume-allocated air flow has been assisting ARDS care, and new ventilatory strategies might also additionally probably benefit the ground. To begin, flight direction stress launch air flow (APRV) is a stress manipulation machine of respiration that has been proven to decrease ventilator-instigated lung harm. Rather than endeavoring to broaden the lung to perfect lung volumes with the aid of using beating heartbreaking consistency with better strains, this approach conflictingly breakdowns the lungs ("launch") from an extra unmistakable stage of constant positive flying direction stress. APRV may want to limit ventilator-instigated lung harm on an essential stage with the aid of using assisting predictable pressures at veritable levels. However, every other randomized author determined that APRV had a crucial impact on ARDS fulfillment rates, with decreased mechanical breathing time and period of life withinside the ICU whilst separated from volume-managed air flow with protection, that is pulmonary correlated (Zhou *et al*., 2017). Further medical reviews of APRV brains are needed. Another interesting location of evaluation is the capability for lung damage from self-damage to the lung (P-SILI). Despite the sturdy physiological clarity, there may be a loss of human manipulation to recognize P-SILI (Tobin *et al*., 2020). In a prime stage, the dangers of P-SILI may be decreased with the aid of using controlling breathing motion and attempt with neuromuscular tape, sedation, or laboratory assistance. It is accurate now inadequate regarding affirmation that diminishing breathing attempts and power is hooked up with more made accomplishes ARDS sufferers (Spinelli *et al*., 2020).

Finally, at the same time as VV-ECMO is precious for sufferers with over-the-pinnacle ARDS for whom the popular concept is failing, extracorporeal carbon dioxide clearing is one extra type of extracorporeal lifestyle assist that can be primary withinside the courting of moderate-to-severe ARDS (Del Sorbo *et al*., 2014). There is a wagered of hypoventilation in sufferers getting mechanical air flow with fantastically low streaming volumes, attaining hypercapnia and acidosis. By supplying an extracorporeal method for slashing down carbon dioxide, extracorporeal carbon dioxide clearing can allow quite low streaming volumes. Not with the aid of using any stretch like VV-ECMO, this technique makes use of extra diffused catheters, but there are essential dangers associated with it, maximum extraordinarily depleting (Boyle *et al*., 2018). In individuals with mild ARDS, the extracorporeal release of carbon dioxide can be interrupted and lead to annoying confusion. The essential clinical elements to explore its richness are underway.

## Conclusion

Intense respiratory misery disorder is a kind of respiratory capture brought about by pneumonia, sepsis, injury, or goal. The level of hypoxemia in ARDS is related to an expanded gamble of death. ARDS the board centers principally around strong consideration, lung-defensive ventilation, and diminishing the kind of iatrogenic lung injury, and extracorporeal life support is the final retreat for patients who keep on falling apart regardless of these steady medicines. Intense respiratory pain condition related to COVID-19 seems, by all accounts, to be the same as customary ailments, and current prescriptions ought to keep on being the backbone of therapy.

**Acknowledgments:** None

**Conflict of interest:** None

**Financial support:** None

**Ethics statement:** None

## References

Acute Respiratory Distress Syndrome Network. (2000). Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. *New England Journal of Medicine*, *342*(18), 1301-1308.

Ahmed, H. G., Alquwaiay, F. K., Al-Dhamadi, H. F., Alzamil, A. F., Alshammari, I. H. E., & Altayep, K. M. (2020). Acute respiratory distress syndrome (ARDS) in hail region, Saudi Arabia. *International Journal of Pharmaceutical Sciences and Research*, 987-992.

Aleanizy, F. S., Alqahtani, F. Y., Alanazi, M. S., Mohamed, R. A., Alrfaei, B. M., Alshehri, M. M., AlQahtani, H., Shamlan, G., Al-Maflehi, N., Alrasheed, M. M., et al. (2021). Clinical characteristics and risk factors of patients with severe COVID-19 in Riyadh, Saudi Arabia: A retrospective study. *Journal of Infection and Public Health*, *14*(9), 1133-1138.

Alfarwati, T. W., Alamri, A. A., Alshahrani, M. A., & Al-Wassia, H. (2019). Incidence, risk factors and outcome of respiratory distress syndrome in term infants at Academic Centre, Jeddah, Saudi Arabia. *Medical Archives*, *73*(3), 183.

Alharbi, A. A., Alqumaizi, K. I., Bin Hussain, I., Alsabaani, A., Arkoubi, A., Alkaabba, A., AlHazmi, A., Alharbi, N. S., Suhail, H. M., & Alqumaizi, A. K. (2022). Characteristics of hospitalized COVID-19 patients in the four southern regions under the proposed Southern Business Unit of Saudi Arabia. *International Journal of General Medicine, 15*, 3573-3582.

Amato, M. B. P., Barbas, C. S. V., Medeiros, D. M., Magaldi, R. B., Schettino, G. P., Lorenzi-Filho, G., Kairalla, R. A., Deheinzelin, D., Munoz, C., Oliveira, R., et al. (1998). Effect of a protective-ventilation strategy on mortality in the acute respiratory distress syndrome. *New England Journal of Medicine*, *338*(6), 347-354.

Ashbaugh, D., Bigelow, D. B., Petty, T., & Levine, B. (1967). Acute respiratory distress in adults. *The Lancet*, *290*(7511), 319-323.

Bellani, G., Laffey, J. G., Pham, T., Fan, E., Brochard, L., Esteban, A., Gattinoni, L., van Haren, F., Larsson, A., McAuley, D. F., et al. (2016). Epidemiology, patterns of care, and mortality for patients with acute respiratory distress syndrome in intensive care units in 50 countries. *Jama*, *315*(8), 788-800.

Bellani, G., Laffey, J. G., Pham, T., Madotto, F., Fan, E., Brochard, L., Esteban, A., Gattinoni, L., Bumbasirevic, V., Piquilloud, L., et al. (2017). Noninvasive ventilation of patients with acute respiratory distress syndrome. Insights from the LUNG SAFE study. *American Journal of Respiratory and Critical Care Medicine*, *195*(1), 67-77.

Bernard, G. R., Artigas, A., Brigham, K. L., Carlet, J., Falke, K., Hudson, L., Lamy, M., Legall, J. R., Morris, A., & Spragg, R. (1994). The American-European Consensus Conference on ARDS. Definitions, mechanisms, relevant outcomes, and clinical trial coordination. *American Journal of Respiratory and Critical Care Medicine*, *149*(3), 818-824.

Boyle, A. J., Sklar, M. C., McNamee, J. J., Brodie, D., Slutsky, A. S., Brochard, L., & McAuley, D. F. (2018). International ECMO Network (ECMONet). Extracorporeal carbon dioxide removal for lowering the risk of mechanical ventilation: research questions and clinical potential for the future. *The Lancet Respiratory Medicine*, *6*(11), 874-84.

Briel, M., Meade, M., Mercat, A., Brower, R. G., Talmor, D., Walter, S. D., Slutsky, A. S., Pullenayegum, E., Zhou, Q., Cook, D., et al. (2010). Higher vs lower positive end-expiratory pressure in patients with acute lung injury and acute respiratory distress syndrome: systematic review and meta-analysis. *Jama*, *303*(9), 865-873.

Cochi, S. E., Kempker, J. A., Annangi, S., Kramer, M. R., & Martin, G. S. (2016). Mortality trends of acute respiratory distress syndrome in the United States from 1999 to 2013. *Annals of the American Thoracic Society*, *13*(10), 1742-1751.

Corrêa, T. D., Sanches, P. R., de Morais, L. C., Scarin, F. C., Silva, E., & Barbas, C. S. V. (2015). Performance of noninvasive ventilation in acute respiratory failure in critically ill patients: A prospective, observational, cohort study. *BMC Pulmonary Medicine*, *15*(1), 1-8.

Del Sorbo, L., Cypel, M., & Fan, E. (2014). Extracorporeal life support for adults with severe acute respiratory failure. *The Lancet Respiratory Medicine*, *2*(2), 154-164.

Fan, E., Beitler, J. R., Brochard, L., Calfee, C. S., Ferguson, N. D., Slutsky, A. S., & Brodie, D. (2020). COVID-19-associated acute respiratory distress syndrome: Is a different approach to management warranted? *The Lancet Respiratory Medicine*, *8*(8), 816-821.

Fan, E., Brodie, D., & Slutsky, A. S. (2018). Acute respiratory distress syndrome: Advances in diagnosis and treatment. *Jama*, *319*(7), 698-710.

Fan, E., Del Sorbo, L., Goligher, E. C., Hodgson, C. L., Munshi, L., Walkey, A. J., Adhikari, N. K., Amato, M. B., Branson, R., Brower, R. G., et al. (2017). An official American Thoracic Society/European Society of Intensive Care Medicine/Society of Critical Care Medicine clinical practice guideline: mechanical ventilation in adult patients with acute respiratory distress syndrome. *American Journal of Respiratory and Critical Care Medicine*, *195*(9), 1253-1263.

Ferguson, N. D., Cook, D. J., Guyatt, G. H., Mehta, S., Hand, L., Austin, P., Zhou, Q., Matte, A., Walter, S. D., Lamontagne, F., et al. (2013). High-frequency oscillation in early acute respiratory distress syndrome. *New England Journal of Medicine*, *368*(9), 795-805.

Florina, M. G., Mariana, G., Csaba, N., & Gratiela, V. L. (2022). The Interdependence between diet, microbiome, and human body health-a systemic review. *Pharmacophore*, *13*(2), 1-6.

Gattinoni, L., Chiumello, D., Caironi, P., Busana, M., Romitti, F., Brazzi, L., & Camporota, L. (2020). COVID-19 pneumonia: Different respiratory treatments for different phenotypes? *Intensive Care Medicine*, *46*, 1099-1102.

Griffiths, M. J. D., McAuley, D. F., Perkins, G. D., Barrett, N., Blackwood, B., Boyle, A., Chee, N., Connolly, B., Dark, P., Finney, S., et al. (2019). Guidelines on the management of acute respiratory distress syndrome. *BMJ Open Respiratory Research*, *6*(1), e000420.

Herridge, M. S., Cheung, A. M., Tansey, C. M., Matte-Martyn, A., Diaz-Granados, N., Al-Saidi, F., Cooper, A. B., Guest, C. B., Mazer, C. D., Mehta, S., et al. (2003). One-year outcomes in survivors of the acute respiratory distress syndrome. *New England Journal of Medicine*, *348*(8), 683-693.

Herridge, M. S., Tansey, C. M., Matté, A., Tomlinson, G., Diaz-Granados, N., Cooper, A., Guest, C. B., Mazer, C. D., Mehta, S., Stewart, T. E., et al. (2011). Functional disability 5 years after acute respiratory distress syndrome. *New England Journal of Medicine*, *364*(14), 1293-1304.

Kao, K. C., Hu, H. C., Hsieh, M. J., Tsai, Y. H., & Huang, C. C. (2015). Comparison of community-acquired, hospital-acquired, and intensive care unit-acquired acute respiratory distress syndrome: A prospective observational cohort study. *Critical Care*, *19*(1), 1-10.

Mahmoud, E. S., Baharoon, S. A., Alsafi, E., & Al-Jahdali, H. (2016). Acute respiratory distress syndrome complicating community-acquired pneumonia secondary to mycobacterium tuberculosis in a tertiary care center in Saudi Arabia. *Saudi Medical Journal*, *37*(9), 973.

Navas-Blanco, J. R., & Dudaryk, R. (2020). Management of respiratory distress syndrome due to COVID-19 infection. *BMC Anesthesiology*, *20*, 1-6.

Papazian, L., Aubron, C., Brochard, L., Chiche, J. D., Combes, A., Dreyfuss, D., Forel, J. M., Guérin, C., Jaber, S., Mekontso-Dessap, A., et al. (2019). Formal guidelines: Management of acute respiratory distress syndrome. *Annals of Intensive Care*, *9*(1), 1-18.

Rochwerg, B., Granton, D., Wang, D. X., Helviz, Y., Einav, S., Frat, J. P., Mekontso-Dessap, A., Schreiber, A., Azoulay, E., Mercat, A., et al. (2019). High flow nasal cannula compared with conventional oxygen therapy for acute hypoxemic respiratory failure: A systematic review and meta-analysis. *Intensive Care Medicine*, *45*, 563-572.

Saaty, A. H., & Aljadani, H. M. (2021). Investigating the influence of COVID-19 quarantine on health-related determinants among Saudi adults: A qualitative study. *Pharmacophore*, *12*, 68-76.

Sadeghi, M., Rahimi, M., Poornoroz, N., & Jahromi, F. F. (2021). Patient satisfaction with hospital services after the implementation of the health system. *Archives of Pharmacy Practice*, *12*(1).

Shi, Y., Wang, L., Yu, S., Ma, X., & Li, X. (2022). Risk factors for developing acute respiratory distress syndrome in sepsis patients: A retrospective study from a tertiary hospital in China.

Slutsky, A. S., & Ranieri, V. M. (2013). Ventilator-induced lung injury. *New England Journal of Medicine*, *369*(22), 2126-2136.

Spinelli, E., Mauri, T., Beitler, J. R., Pesenti, A., & Brodie, D. (2020). Respiratory drive in the acute respiratory distress syndrome: Pathophysiology, monitoring, and therapeutic interventions. *Intensive Care Medicine*, *46*, 606-618.

Tobin, M. J., Laghi, F., & Jubran, A. (2020). P-SILI is not justification for intubation of COVID-19 patients. *Annals of Intensive Care*, *10*(1), 1-2.

Zhou, Y., Jin, X., Lv, Y., Wang, P., Yang, Y., Liang, G., Wang, B., & Kang, Y. (2017). Early application of airway pressure release ventilation may reduce the duration of mechanical ventilation in acute respiratory distress syndrome. *Intensive Care Medicine*, *43*, 1648-1659.