International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

Acute Respiratory Distress Syndrome: A Literature Review

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Abstract: ***Acute respiratory distress syndrome (ARDS) is a life - threatening condition characterized by severe hypoxemia due to failure of pulmonary gas exchange and was first recognized in the 1960s. Since it was first described, intensive research in the last few decades has been carried out to understand its pathogenesis and therapy. However, recommended therapies with the aim of reducing mortality from ARDS are limited, including mechanical use of low tidal volumes, prone position ventilation and, more recently, ECMO therapy in extreme cases. This article will summarize the keys to managing ARDS with a brief overview of the therapeutic options in the management of ARDS.***

Keywords: acute respiratory distress syndrome (ARDS), the Berlin definition

1. Introduction

Acute respiratory distress syndrome (ARDS) is a lung injury caused by acute, life - threatening inflammation manifested by hypoxia and lung stiffness caused by increased pulmonary vascular permeability and almost always requires mechanical ventilation. [1] ARDS is an acute response to various precipitating and etiologic factors that become risk factors, which in the end is a cloudy two - field picture depicted in radiological results and hypoxaemia.

ARDS was first described by Ashbaugh et al. in 1967, [2] and since then there have been many studies discussing the clinical aspects of the syndrome, its pathogenesis, risk factors, and the therapies used. However, apart from intensive research, not all therapies for ARDS have been found, including therapeutic strategies used to protect the lungs from damage.

2. Definition

ARDS was first defined in 1994 by the American - European Consensus Conference (AECC) as acute - onset hypoxemia (comparison of arterial partial pressure of oxygen to inspired fraction of oxygen [PaO2/FIO2] 200 mm Hg) with bilateral infiltrates on frontal chest radiographs. Without left a trial hypertension and acute lung injury (ALI) were defined using the same criteria, but had a PaO2/FIO2 of 300 mm Hg. [3] Over the years, ongoing research into the definition of this topic and issues of validity and reliability have emerged.

Experts gathered in 2011 (an initiative undertaken by the European Society of Intensive Care Medicine supported by the American Thoracic Society and the Society of Critical Care Medicine) and developed the Berlin definition of ARDS using the convention process. [1]

The Berlin definition provides four criteria for meeting the diagnosis of ARDS

1) **Timing:** respiratory symptoms must have started within one week of the clinical disturbance experienced, or have had new symptoms that have worsened over the past week.
2) **Chest radiograph:** cloudiness in both lung fields that tends to be consistent with pulmonary edema should be seen on the chest radiograph, which is not fully delineated because of pleural effusion, lobe collapse, lung collapse, or pulmonary nodules.
3) **Origin of edema:** The patient's respiratory failure is not only caused by heart failure or fluid. Objective assessment (eg echocardiography) to prevent other diagnoses such as hydrostatic pulmonary edema in the absence of risk factors for ARDS.
4) **Oxygenation:** There should be moderate to severe impairment of oxygenation, as determined based on the PaO2/FiO2 ratio.

The severity of hypoxemia determines the severity of ARDS: (1) mild ARDS if PaO2/FiO2 > 200 mmHg, but if < 300 mmHg, using a positive end - expiratory pressure (PEEP) ventilator or with sustained positive airway pressure >5 cm H2O. (2) moderate ARDS when the PaO2/FiO2 ratio > 100 mmHg, but the PaO2/FiO2 ratio < 200 mmHg, using a ventilator with PEEP > 5 cm H2O. (3) ARDS is severe or severe when the PaO2/FiO2 ratio is 100 mmHg using a ventilator with a PEEP setting of 5 cm H2O.

When comparing the AECC definition with the Berlin definition, the Berlin definition of ARDS can predict patient mortality better. Mortality rates associated with advancing ARDS stage: mild 27% 32%, and severe 45% with 95% CI. [1]

3. Patophysiology

ARDS is a condition caused by alveolar injury caused by various clinical conditions that result in diffuse alveolar damage. This damage causes proinflammatory cytokine factors (tumor necrosis, interleukin (IL) - 1, IL - 6, IL - 8), which result in the entry of neutrophils into the lungs, where they are activated and then release toxic mediators (such as reactive oxygen). and proteases) that damage the capillary endothelium and alveolar epithelium, resulting in alveolar edema. [4] This, in turn, results in impaired gas exchange, decreased pulmonary compliance, and pulmonary artery pressure.

Pathological process that occurs: exudative stage, starting with the occurrence of diffuse alveolar damage. The second stage is proliferation which develops in approximately 10 - 14 days, characterized by resolution of pulmonary edema, proliferation of type II alveolar cells, squamous metaplasia, interstitial infiltration by myofibroblasts, and early collagen deposition. Some patients develop a condition that progresses to the third stage of fibrosis, characterized by loss of normal lung changes, diffuse fibrosis, and cyst formation.

4. Treatment

4.1Ventilation as lung protection

Experiments and studies have shown that the use of mechanical ventilation with a lower tidal volume (LTV) and airway pressure (tidal volume 4 - 6 ml/kg body weight and maintaining a plateau pressure between 25 and 30 cm H2O) reduces mortality in ALI. and ARDS.6] This mechanical ventilation maintains the protective alveolar endothelium and alveolar epithelium by preventing alveolar over distension, which is one of the main causes of lung damage caused by the use of ventilators. [6 - 11] The concept of open lung ventilation uses low tidal volumes. Using high PEEP minimizes cycle atelectasis [6], this method is proven to provide better effect and outcome for patients. Ventilation with the goal of lung protection also regulates pro - inflammatory sensitive mechanical pathways, resulting in decreased neutrophil accumulation in the alveoli and reduced plasma levels of IL - 6, IL - 8, and TNF. [7, 12]

4.2 Prone Ventilation

Ventilation in the prone position provides evidence of oxygenation and thus improves outcomes with ARDS with severe hypoxia. [13 - 15] this is caused by a reduction in transpulmonary pressure in the prone patient, which helps to improve function of the collapsed lung area without a significant increase in airway pressure. In a study conducted by De Jong et al. (2013), prone position ventilation was found to be significantly effective in obese patients with ARDS compared to non - obese patients.

4.3 Extra corporeal membrane oxygenation use in ARDS

ECMO is a circulatory and ventilation support system which is used to salvage persistent hypoxaemic conditions, when conventional therapy fails to give good results. This technique has been successful in helping patients with severe ARDS and demonstrated by the CESAR trial in 2009, the evidence that ECMO is a circulatory and ventilation support system that can be used as a priority first choice still requires further research.]

4.4 High – frequency oscillatory ventilation

High Frequency Oxygen Oscillation (HFOV) seems ideal for lung protection in ARDS, but the OSCAR study concluded within 30 days in patients using this system. Meta - analysis of the randomized controlled trial (RTC) by GU et al. concluded that the use of HFOV did not show significant efficacy in patients with ARDS although it did not increase the risk of barotrauma or hypotension and also reduced the risk of failed oxygenation.

4.5 Use of Neuromuscular Blocking Agents

Neuromuscular blocker agents (NMBAs) are commonly used in patients with ARDS, but are still controversial. In a recent meta - analysis and review of their use in the short term, NMBAs in ARDS have shown distinct advantages with good outcomes by reducing the risk of barotrauma and lung injury caused by use of ventilators

4.6 Fluid Therapy in ARDS

In patients with ARDS due to increased alveolar vascular permeability, there is alveolar edema that may worsen as a result of excessive fluid accumulation. Conservative therapy with a fluid therapy approach in ARDS has been shown to provide better outcomes and reduce the length of time on a ventilator but does not increase survival.

4.7 Intravenous β - 2agonistinARDS

The BALTI trial is a central RCT, which demonstrated the benefits of intravenous salbutamol for 7 days in patients with ARDS, with significant reductions in extrapulmonary fluid or in airway plate pressure. Apart from that, recent studies from the BALTI 2 trial, have shown that the administration of a beta 2 agonist, namely salbutamol in patients with ARDS did not provide significant improvement results and concluded that it may have a significant adverse effect that can increase mortality.

4.8 Corticosteroids Use in ARDS

ARDS, apart from being an acute inflammatory process accompanied by damage to inflammatory cells and mediators, the use of anti - inflammatory corticosteroids did not show significant improvement. A systematic review and meta - analysis conducted by RUAN that included 8 RCTs and 10 cohort studies concluded that corticosteroid use can be very dangerous in some patients and is not recommended for routine use in ARDS patients.

4.9 Experimental trial on ARDS

In ARDS experiments performed on mice, bone marrow - derived mesenchymal stem cells (MSCs) reduced the severity of ventilator - induced lung damage by improving lung tissue regeneration [28, 29]. Research shows that MSCs are beneficial because they can reduce the production of inflammatory mediators, leukocyte infiltration, tissue injury, and pulmonary function failure.

5. Conclusion

Much research has been done on ARDS in recent decades and a better understanding of the pathogenesis of ARDS itself has been made. However, effective therapy with the aim of reducing mortality in ARDS uses mechanical ventilation with low tidal volume, prone ventilation for severe cases of ARDS; and in life - threatening cases where

there is no significant response to conventional therapy, using ECMO may be an option with better recovery.

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Author Profile

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