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# RESPIRATORY DISTRESS SYNDROME

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**Abstract**

Respiratory distress syndrome (RDS) is a common condition which is caused by pulmonary and extra-pulmonary pathologies, and it carries high rates of mortality and morbidity. It was first described 50 years ago. The definition is non-cardiogenic pulmonary edema that occurs because of an inflammatory process that increases capillary membranes permeability leading to impairment in oxygenation and gas exchange presenting with hypoxemia and bilateral pulmonary infiltrates. This activity examines when this condition should be considered on a differential diagnosis and how to properly evaluate for it. This activity highlights the role of the interprofessional team in caring for patients with this condition.

**Keywords:** RDS, mortality, physical examination, fibrotic phase, PEEP, ICU, epithelial barrier damage.

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**Introduction.** Respiratory distress syndrome (RDS) is a common condition which is caused by pulmonary and extra-pulmonary pathologies, and it carries high rates of mortality and morbidity. It was first described 50 years ago. The definition is non-cardiogenic pulmonary edema that occurs because of an inflammatory process that increases capillary membranes permeability leading to impairment in oxygenation and gas exchange presenting with hypoxemia and bilateral pulmonary infiltrates.

**Purpose.** The main goals are:

- ✓ Identify the etiology of RDS.
- ✓ Review the presentation of a patient with RDS.
- ✓ Outline the treatment and management options available for RDS.
- ✓ Describe interprofessional team strategies for improving care and outcomes in patients with RDS.

**Epidemiology**

RDS is a common condition in critical illness settings affecting 200000 patients in the United States and 3 million patients worldwide every year. It accounts for 10% admissions to intensive care units and is responsible for 24% of patients requiring invasive mechanical ventilation. Mortality rates range between 35 to 45% with 75000 deaths annually in the United States, a number which is more than mortality caused by breast cancer and HIV.

**Pathophysiology.** There are three distinct phases in the development of RDS: exudative, proliferative and fibrotic phase. The first exudative phase that occurs over the first 7 to 10 days occurred after lung exposure to injury with subsequent activation of an inflammatory cascade leading to the accumulation of protein-rich fluid and hemorrhage secondary to alveolar endothelial and epithelial barriers damage. In the second proliferative phase, the repair process takes place by restoration of epithelial and endothelial barriers and reestablishing the epithelial integrity with the absorption of the intra-alveolar fluid that enhances functional recovery. The fibrotic phase which does not occur in all patients is associated with fibrous tissue formation and linked to increased mortality and prolonged duration of mechanical ventilation.

**History and Physical**. Dyspnea is the common presenting symptom usually occurring immediately after exposure to the inciting event. Physical examination shows signs of respiratory distress with tachycardia, tachypnea, and diffuse crackles. In severe cases, patients are somnolent, cyanosed and diaphoretic.

**Evaluation**. RDS is diagnosed clinically based on the diagnostic Berlin criteria:

- Development of new-onset respiratory symptoms within one week of known clinical insult
- Bilateral opacities are apparent on chest radiograph or computed tomography which are not fully explained by other condition such as lobar or lung collapse, pleural effusions, and pulmonary nodules
- Respiratory failure not fully explainable by cardiogenic pulmonary edema or fluid overload - objective assessment such as echocardiography is needed to rule out left ventricular dysfunction and hydrostatic edema in the absence of risk factors for RDS
- Hypoxemia defined as partial arterial oxygen pressure to a fraction of inspired oxygen (PaO2/FiO2) ratio is less than or equal to 300 mmHg

The severity of RDS is classified according to the PaO2/FiO2 ratio on a mechanical ventilator with minimum positive end-expiratory pressure (PEEP) or continuous positive airway pressure of 5 cm water. Classifications are mild (PaO2/FiO2 ratio less than or equal to 300 but greater than 200), moderate (PAO2/FiO2 ration less than or equal to 200 but greater than100) and severe (PaO2/FiO2 less than or equal to 100mmHg).

Diffuse bilateral opacities and infiltrates classically present on chest radiograph, but these findings could be variable showing lobar, dependent or unilateral opacities. Computed tomography usually shows widespread patchy airspace opacities more evident in the dependent areas[1].

In most situations, the diagnosis and etiology will be evident and confirmed after an initial evaluation. In a small number of patients, the diagnosis and/or etiology is unclear, so further evaluation and diagnostic testing are warranted to confirm the diagnosis and etiology or rule out other diagnoses. These tests could include echocardiography to assess for ventricular function and valvular abnormalities, right side heart catheterizations and bronchoscopy with bronchoalveolar lavage and possibly lung tissue biopsy[2].

**Treatment.** Management of patients with RDS requires the collaboration of the medical team with the goal of preventing further complications. Besides the focus on mechanical ventilation, management of these patients requires attention to treatment and recognition of the underlying cause, minimization of unnecessary procedures, prophylaxis for venous thromboembolism, stress ulcers, and aspiration. Additionally, one should ensure adequate nutrition via the enteral route when possible, and minimize the risk of acquired nosocomial infections [3,4].

Safe mechanical ventilation with avoiding further lung injury is the cornerstone of treatment in RDS. Current guidelines recommend lung protective ventilation consists of low tidal volumes (4 to 8 ml/kg of ideal body weight) with a target of plateau airway pressure less than 30 cm of water. Usually, tidal volume starts at 6ml/kg of ideal body weight and lowers further for 4 ml/kg if plateau airway pressure is less than 30 and could increase to 8 ml/kg if inspiratory plateau pressure below PEEP or patient is double triggering or in cases of severe hypercapnia and metabolic acidosis. This approach is associated with decreased mortality and improved clinical outcomes at 30 days as shown in different trials. Furthermore, in patients with moderate-to-severe RDS (PaO2/FiO2 less than or equal to 150 mmHg), the American Thoracic Society and European Respiratory Society (ATS/ERS) recommend the prone position for 12 hours per day especially in patients with resistant hypoxemia. Conservative fluid strategy is recommended in patients with RDS to decrease the risk of fluid accumulation in alveolar space as it associated with a reduction of the duration of mechanical ventilation and ICU stay with an improvement of lung function without causing non-pulmonary organ dysfunction.

Several other measures are used in patients with severe RDS. Early use of neuromuscular blockade and deep sedation in patients with moderate-to-severe RDS correlates with 90-day survival without

increasing the risk for muscle weakness.[10] Higher rather than lower PEEP has a conditional recommendation in patients with moderate-to-severe RDS. It might be required to prevent atelectotrauma and to achieve oxygenation, but it has potential risk factors including end-expiratory alveolar distention, barotrauma, increasing intra-pulmonary shunts and higher pulmonary vascular resistance that could lead to cor-pulmonale. Furthermore, recruitment maneuvers involve elevation of applied ventilation pressures transiently to open collapsed alveoli which increases the tidal volume participating in the gas exchange. Several recruitment maneuvers are used including prolonged high continuous PEEP, an incremental increase in PEEP and high driving pressures. However, ATS/ERS has a conditional recommendation for lung recruitment in patients with RDS, and it should be used cautiously especially in patients with hypovolemia and shock[5].

Several measures may have promising results in the management of RDS and are under investigation by many ongoing randomized controlled trials. These measures include extracorporeal membrane oxygenation (ECMO) is reserved for very severe RDS (PaO2/FiO2 ratio less than or equal to 60). As well, PEEP titration guided by transpulmonary plateau pressure which involves estimating pleural pressures using esophageal manometer results in lower mortality in a small trial and is being investigated by two ongoing studies. Furthermore, other trials are studying ultra-low tidal volume (less than 4ml/kg IBW) with CO2 removal by extracorporeal methods which will allow for low pressure and avoiding hypercapnia and acidosis[6].

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