2019

Acute Respiratory Distress Syndrome

Amelia Morgan
morgan2@otterbein.edu

Acute Respiratory Distress Syndrome

Amelia Morgan, MSA, BSN, RN, CCRN
Otterbein University, Westerville, Ohio

Introduction

Acute respiratory distress syndrome (ARDS) was first recognized as a pulmonary syndrome in 1967 (Cutts et al., 2010). ARDS is "characterized by poor oxygenation and non-compliant or 'stiff' lungs" associated with capillary endothelial injury and diffuse alveolar damage (Peniston Feliciano & Mahapatra, 2019). Though it was first identified in the civilian population in the United States, it gained notoriety during the Vietnam War, where it became known as Nam Lung, among other pseudonyms (Cutts et al., 2010).

In 2011, a team of American and European doctors redefined ARDS in what's known as the Berlin definition. This definition divides ARDS patients into three categories ranging from mild to moderate to severe, based on their PaO2/FiO2 ratios (Peniston Feliciano & Mahapatra, 2019). Currently, ARDS remains a life-threatening condition with mortality rates of 9-20% (Peniston Feliciano & Mahapatra, 2019), though Dreyfuss and Hubmayr report that rates have fallen to just below 40% (2016). This is a dramatic improvement from the 1990's when mortality rates were between 50-60% (Nerlich, 1997).

Process of Pathophysiology

Signs & Symptoms

- Sudden onset of hypoxemic respiratory failure,
- Severe inflammatory response
- Presence of diffuse bilateral pulmonary infiltrates on chest x-ray,
- Usually does not manifest with left ventricular failure or circulatory overload, but often leads to cor pulmonale (right heart failure due to sharp rise in pulmonary pressures) (Dalmedico, et al., 2017)

Diagnosis

Once the diagnosis is made from the clinical presentation and radiographic evidence, it is further classified according to the Berlin consensus:

- Mild (PaO2/FiO2 </=300 mm/Hg with PEEP or CPAP >/= 5 cmH2O)
- Moderate (PaO2/FiO2 </=200 mm/Hg with PEEP or CPAP >/= 5 cmH2O)
- Severe (PaO2/FiO2 </=100 mm/Hg with PEEP or CPAP >/= 5 cmH2O)

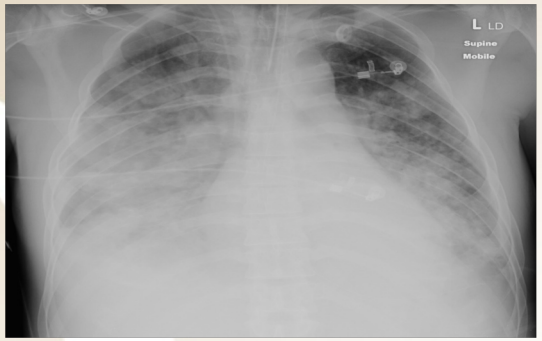
(Dalmedico, et al., 2017)

Risk Factors

Preceding noxious event such as:

- Sepsis
- Shock
- Pancreatitis
- Pneumonia
- Aspiration
- High-risk trauma
- High-risk surgery, such as cardiac or esophageal

(Brower, 2016)



Case courtesy of Dr Craig Hacking, Radiopaedia.org, rID: 53759
Chest radiograph showing bilateral pulmonary infiltrates in patient with ARDS

Reason for Topic

As a student nurse anesthetist, the importance of understanding the pathophysiology and implications of ARDS in the perioperative patient will improve patient care. Staying abreast of current research and developments enables providers to affect morbidity and mortality rates.

- Historically, clinicians presented hypoxemic patients with "stiff" lungs would increase the tidal volume on the ventilator to volumes as high as 24 mL/kg. The resulting high transpulmonary pressures resulted in volutrauma, hemorrhage, and damage to the tissue matrix of the lungs (Dreyfuss & Hubmayr, 2016).
- By 1998, tidal volumes in ARDS patients had decreased to levels around 9 mL/kg of actual body weight (Dreyfuss & Hubmayr, 2016).
- The concept of ventilator-induced lung injury (VILI) has had a major impact on ventilator management by critical care and anesthesia providers. Current recommended tidal volumes are between 6-8 mL/kg, but may be as low as 4 mL/kg with permissive hypercapnia in order to keep driving pressures low and prevent additive lung injury (Dalmedico, et al., 2017).

Pathophysiology

Acute respiratory distress syndrome (ARDS) has been defined as "a potentially devastating from of hypoxemic respiratory failure caused by acute inflammatory lung injury (Dalmedico, et al., 2017). The exact cause or trigger for ARDS is unknown. The lung injury prediction score (LIPS) is a tool that may be used at hospital admission and has been validated to be an accurate predictor of ARDS risk. Patients at highest risk for developing ARDS are "patients with sepsis, shock, pancreatitis, pneumonia, aspiration, high-risk trauma, and high-risk surgery," such as cardiac or esophageal (Brower, 2016). The noxious event that precedes ARDS results in increased permeability of the capillary membrane and pulmonary edema (Nagelhout & Elisha, 2018).

"ARDS is better described as a syndrome without a consistent pathogenesis" this limits treatment and prevention strategies (Dries, 2019) and helps to explain why there is a lack pathophysiological definition of ARDS in the literature. In 2012 the ARDS Definition Task Force proposed a now widely accepted model for three categories to clinically predict severity of ARDS.

In the early stages of ARDS, there are intense inflammatory processes and severe damage occurring in the alveolar-capillary membrane of the lungs. The complement system is activated in response to release of cytokines and membrane-bound phospholipids (Nagelhout & Elisha, 2018). It is thought that this response also decreases the lungs ability to promote hypoxic pulmonary vasoconstriction (HPV). Under normal HPV is a protective mechanism that allows the pulmonary vasculature to shunt blood away from poorly ventilated areas of the lung to areas that are better ventilated, thus decreasing the ventilation-perfusion mismatch. Damage to the alveolar-capillary membrane also impairs oxygenation and decreases lung compliance making it difficult to ventilate the patient (Nagelhout & Elisha, 2018).

Significance of Pathophysiology

- Scientific evidence suggests that hypoxemia resulting from ARDS is best treated with a combination of lung protective ventilatory strategies with driving pressures (PIP minus PEEP) kept below 16 cmH2O and prone positioning for periods of 16 to 20 hours in patients with severe ARDS (Delmedico, et al., 2017).
- Placing patient in prone position reduces pleural pressure gradients and also unloads the weight of the ventral lungs, heart and abdominal contents, allowing more even lung ventilation and further reducing ventilation-perfusion mismatch (Dries, 2019).
- Prone positioning also enhances venous return to the right atrium, as it is in a more ventral position (Dries, 2019).
- The use of neuromuscular blockade in the early stages of severe ARDS prevents spontaneous respiratory efforts that causes worsening of pulmonary edema and injury, due to an increase in negative pleural pressure. This mechanism of patient self-inflicted lung injury exacerbates lung injury and worsens lung stress (Wawrzeniak, Vieira, & Victorino, 2018).
- Severe ARDS may lead to cor pulmonale and right ventricular failure, especially in the setting of very low tidal volumes and permissive hypercapnia.

Implications for Nursing Care

- As Berry (2015) reports, preparing a patient for prone positioning is an arduous task which may require multiple nurses and respiratory therapists, depending on their level of experience and comfort with positioning and specialized equipment to ensure safe positioning. The use of a Rotoprone bed requires expert knowledge of both the pathophysiology of ARDS and familiarity of the bed's functions. Care must be taken to protect skin and bony prominences with foam dressings and to maintain tubes and lines during pronation.
- ARDS survivors frequently have long-lasting psychiatric effects from their critical illness including post-traumatic stress disorder (PTSD), anxiety, and depression. Rates of psychiatric morbidity after surviving ARDS are as high as 52% (Bienvenu, et al., 2017). Delirium prevention and sleep promotion in the ICU are strategies that nurses can affect every day at the bedside and may have an impact on psychiatric stress of critical illness (Bienvenu, et al., 2017).
- Lung protective strategies continue to evolve. There is some controversy between whether or not to allow permissive hypercapnia (Dries, 2019). Disagreement between whether the best approach is to focus on low tidal volumes, driving pressures (peak inspiratory pressures minus positive end expiratory pressures – or PIP minus PEEP), or plateau pressure limits of 30 cmH2O (Dreyfuss & Hubmayr, 2016). Oscillatory ventilation has come and gone and extracorporeal membrane oxygenation (ECMO) remains controversial in the treatment of ARDS, though it does support the use of lower driving pressures (Dreyfuss & Hubmayr, 2016). Nurses must be aware of ever-changing modes of treatment.

Photo curtesy of Becca Mowad
Rotoprone™ bed. Once head gear is applied and top rail is in place, patient is ready to be rotated to prone position.

Conclusion

- Ventilatory support continues to be the cornerstone of ARDS treatment (Dalmedico, et al., 2017), lung protective (low tv or driving pressure), prone, controversy
- "While the ARDS Network's ventilator management protocol has become the standard of care in many institutions, there is ongoing debate how to better tailor ventilator mode and settings to patient-specific information" (Dreyfuss & Hubmary, 2017).
- ARDS remains a life-threatening condition with mortality rates of 9-20% (Peniston Feliciano & Mahapatra, 2019)

References

Brower, Roy, & Massimo, A. (May 2016). What's new in ARDS: Can we prevent it? *Intensive Care Medicine, 42*(5), 772–774. doi:10.1007/s00134-016-4280-0

Cutts, S., Talboys, R., Paspula, C., Ail, D., Premphe, E.M., Fanous, R. (May 31, 2016). History of acute respiratory distress syndrome. *Thelancet.com/respiratory.* doi:10.1016/52213-2600(16)30087-X

Dalmedico, M.M., Salas, D., Oliveira, A.M., Baran, F.D.P., Meardi, J.T., & Santos, M.C., (Jan., 2017). Efficacy of prone position in acute respiratory distress syndrome: Overview of systematic reviews. *Revista Da Escola De Enfermagem Da USP, 51*, 1–8. doi:10.1590/S1980-220X2016048803251

Dreyfuss, D., & Hubmayr, R. (2016). What the concept of VILI has taught us about ARDS management. *Intensive Care Medicine, 42*(5), 811-813. doi:10.1007/s00134-016-4287-6

Dries, D.J. (2019). ARDS from syndrome to disease—Treatment strategies. *Air Medical Journal, 38*(2), 64-67. doi:10.1016/j.amj.2018.12.003

Fuchs, L., Feng, M., Novack, V., Lee, J., Taylor, J., Scott, D., . . . Talmor, D. (2019). The effect of ARDS on survival: Do patients die from ARDS or with ARDS? *Journal of Intensive Care Medicine (Sage Publications Inc.), 34*(5), 374-382. doi:10.1177/0885066617717659

Peniston Feliciano, H.L., & Mahapatra, S. (Mar. 8, 2019). Acute Respiratory Distress Syndrome (ARDS). Treasure Island, FL: StatPearls Publishing. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK436002/

OTTERBEIN UNIVERSITY