Management of Acute Respiratory Distress Syndrome (ARDS)

Michelle Koo

School of Nursing, CSU Stanislaus

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Professor Nadine Pruitt

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Acute Respiratory Distress Syndrome Management

Acute respiratory distress syndrome (ARDS) is a sudden and life-threatening form of respiratory failure that is associated with high mortality rate. ARDS affects approximately 200,000 patients and lead to 75,000 deaths annually in the United States (Fan et al., 2018). On a global scale, ARDS accounts for 10% of all adult ICU admissions and numerous studies have been conducted to improve ARDS patient outcome (Fan et al., 2018). In this paper, the author will describe her experience of caring for patient JW, who was admitted to St. Joseph's Medical Center's respiratory intensive care unit (RICU) with ARDS. The author will discuss the pathophysiology of ARDS, underline three nursing interventions related to ARDS management, and identify Quality and Safety Education (QSEN) concepts that were integrated in the patient's care.

Pathophysiology

In a healthy individual, pulmonary gas exchange normally occurs between the alveoli and a network of capillaries. However, ARDS patients have a disturbance of pulmonary permeability and fluid balance resulting from either direct or indirect lung injury. Common causes of direct lung injury include chest trauma, aspiration of gastric contents, and pneumonia (Harding et al., 2019). While indirect lung injury such as severe traumatic brain injury, acute pancreatitis, and shock are associated with the development of ARDS, sepsis is the most common cause of indirect insult (Harding et al., 2019).

The progression of ARDS is classified into three phases: (1) exudate phase; (2) proliferative phase; and (3) fibrotic phase. The exudative phase occurs during the first 24 to 72 hours and lasts up to 7 days of initial injury (Harding et al., 2019). This phase is characterized by an inflammatory cascade that results in fluid entering the alveolar space, surfactant dysfunction, and atelectasis (Zayed & Askari, 2021). ARDS patients may enter the proliferative phase 1 to 2 weeks after the lung injury. In this phase, there is an attempted restoration of epithelial integrity and reabsorption of excess fluid. However, decreased lung compliance and worsened hypoxemia may be noted in this phase due to thickened alveolar membrane and fibroblastic reaction (Zayed & Askari, 2021). Some patients may progress to the fibrotic phase that typically occurs 2 to 3 weeks after lung injury. This final and irreversible phase is characterized by scarring and lung remodeling that result in reduced surface area for adequate gas exchange (Harding et al., 2019). Clinical manifestations of ARDS include dyspnea, tachypnea, cough, and diffuse crackles (Saguil & Fargo, 2020). Additionally, refractory hypoxemia remains to be the hallmark feature of ARDS patients. Because excess of fluid and atelectasis inhibit inspired gas from entering the alveolar-capillary space, a constant mixing of deoxygenated blood leads to reduced partial pressure of oxygen in arterial blood (PaO_2) despite increase in FiO_2 (Ambati & Yandrapalli, 2021).

Patient JW was admitted to the RICU with a diagnosis of ARDS as she fulfilled the Berlin diagnostic criteria for this condition. The Berlin criteria defines ARDS as an acute onset of lung injury within 1 week of clinical insult, bilateral opacities in chest imaging not explained by other pathology, and respiratory failure not explained by heart failure (Thompson et al., 2017). The Berlin definition also classifies the severity of ARDS based on the PaO_2/FiO_2 ratio. Because JW presented with a PaO_2/FiO_2 ratio of 126 mmHg, she was considered as a moderate case of ARDS.

Nursing Interventions and Management

There is currently no cure for ARDS, so treatment for these patients focuses on providing supportive care. The goal of treatment is to correct hypoxemia and improve respiratory mechanics without developing oxygen toxicity and ventilator-associated complications. The treatment plan for patient JW consisted of lung-protective ventilation, prone positioning, and conservative fluid management.

Lung-protective Ventilation

Because ARDS patients suffer from significant level of respiratory impairment, mechanical ventilation remains to be a mainstay of ARDS treatment. Traditionally, mechanical ventilation uses tidal volumes of 10 to 15 mL/kg, but numerous studies have demonstrated that high tidal volumes are correlated with alveolar overdistension and ventilator-induced lung injury (Saguil & Fargo, 2020). According to Mitchell and Seckel (2018), the 2017 clinical practice guideline from the American Thoracic Society recommends the use of lung-protective ventilation, which includes low-tidal volume, low inspiratory pressure, and positive end-expiratory pressure (PEEP). By starting with low-tidal volume at 6 mL/kg of predicted body weight, ARDS patients will have a reduced risk of developing volutrauma and barotrauma. PEEP, on the other hand, is exerted by the ventilator at the end of each expiration to increase the functional residual capacity (Harding et al., 2019). This setting effectively improves oxygenation by recruiting previously collapsed alveoli for gas exchange.

To evaluate the effectiveness of lung-protective ventilation, a systematic review of six randomized controlled trials involving 1,297 patients was conducted (Hafiz & Stahl, 2018). Patients were assigned to either conventional ventilation group of 10 to 15 mL/kg or low-tidal volume group of 6 mL/kg. Researchers concluded that lung-protective ventilation correlates with a decreased 28-day mortality and hospital mortality rate (Hafiz & Stahl, 2018). While existing literature supports the benefits of lung-protective ventilation, providers must carefully consider the potential risks of this treatment option. Lowering the tidal volume may result in undesired outcomes such as hypercapnia and acidosis which can lead to depressed myocardial contractility and impaired renal perfusion (Hafiz & Stahl, 2018). As patient JW's chest x-ray revealed dense consolidation and opacification across her right lower lobe, mechanical ventilation was rendered to provide respiratory support. Specifically, a low-tidal volume ventilation with PEEP set at 5 cm H_2O was used.

Prone Positioning

Prone positioning is an appropriate intervention to improve oxygenation in ARDS patients. When supine, forces exerted from gravity and chest wall would compress dependent lung fields and lead to uneven aeration. When the patient is placed in the prone position, the dependent lung fields become well-ventilated due to improvements in lung strains and equal distribution of transpulmonary pressure (Mitchell & Seckel, 2018). The current guideline indicates that 16 to 18 hours of prone positioning in patients with severe ARDS is highly recommended, but this intervention is often used as a late strategy due to concerns of complications and a lack of staffing for manual positioning (Mitchell & Seckel, 2018).

The benefit of prone positioning is best illustrated by an analysis of eight random controlled trials in which 2,129 patients were evaluated (Fan et al., 2017). The researchers concluded that prone positioning reduced mortality rate when the duration was greater than 12 hours per day. However, prone positioning must be performed with careful monitoring due to various complications. Research suggested that the incident rate of pressure injury is as high as 46.4% (Lucchini et al., 2020). Other complications associated with prone positioning include tube dislodgement, pneumothorax, and hemodynamic instability (Lucchini et al., 2020). In the case of patient JW, a collaborative effort between three nurses was needed to place the patient in the prone position. The nurse in charge of JW's care also assessed for skin integrity and tubing patency every four hours in case of complications.

Fluid Management

ARDS is a non-cardiogenic pulmonary edema due to an increased permeability of the alveolar-capillary barrier and fluid accumulation in the alveolar space. Because the leakage of protein-rich fluid into the interstitial space leads to an imbalance of oncotic pressure, patients with ARDS are less capable of retaining fluids in the capillaries (Casey et al., 2019). Consequently, these patients are more sensitive to the hydrostatic forces that influence the intravascular volume and more likely to develop pulmonary edema (Casey et al., 2019).

Based on the current understanding of ARDS pathophysiology, extensive research has been conducted to examine the impact of conservative fluid management using diuretics and minimal intravenous fluid administration (Casey et al., 2019). A clinical trial recruited 1,000 individuals with confirmed case of ARDS, and they were randomly assigned to either a conservative or a liberal fluid management group for seven consecutive days (Siegel & Siemieniuk, 2021). In the conservative group, patients underwent fluid management that aimed for central venous pressure (CVP) of 4 mmHg. In the liberal group, the CVP was targeted for 10 mmHg. Although the researchers concluded that the 60-day mortality rate was unchanged between the groups, there were significant improvements in the number of ventilator-free and ICU-free days (Siegel & Siemieniuk, 2021). While studies on fluid management have also shown improved oxygenation and fluid balance, some suggested that a lack of fluid resuscitation may lead to deterioration in ARDS patients with sepsis (Casey et al., 2019). Therefore, further research is warranted to clarify the impact of fluid choice and dosage on patient outcome.

In the case of JW, nurses incorporated several strategies to manage the patient’s fluid balance. To monitor the hemodynamic status, a large bore catheter was inserted into JW’s right internal jugular vein to measure her CVP. CVP accurately reflects fluid balance as it measures the amount of blood returning the right atrium. Additionally, a diuretic treatment was implemented by administering 40 mg furosemide tablet once a day. Strict input and output monitoring was also implemented to track JW's fluid status. Furosemide exerted its therapeutic effect as evidenced by JW excreting 1,700 mL of urine during a 12-hour window.

QSEN Concepts

The QSEN concepts of teamwork and collaboration, patient-centered care, evidence-based practice (EBP) were integrated in the care of patient JW. Firstly, an interdisciplinary healthcare team consisting of physicians, nurses, respiratory therapist, and dietician worked together to care for the patient. While the dietician provided nutritional support, the respiratory therapist was responsible for managing the ventilator setting. The nurse also worked closely together with the physician by constantly giving updates on the patient's respiratory status and pertinent assessment findings. Furthermore, teamwork and collaboration were observed during the handoff reports. The night-shift nurse included important information such as JW's baseline respiratory status, fluid status, ventilator setting, and positioning. An effective exchange of information between nurses is crucial to ensuring patient safety and continuity of care. Secondly, patient-centered care was evident since the RICU nurse respected JW's healthcare needs and preferences. At the beginning of shift, JW made a request of keeping the lights off throughout the day because she had trouble sleeping at night. The nurse respected JW's needs and kept the lights off except when she performed physical assessment. Lastly, the nurse applied the best current practice in JW's care. For instance, the patient was put on lung-protective ventilation with PEEP setting instead of the conventional approach to ensure optimal outcome. Because the conventional approach increases the risk of ventilator-induced lung injury, the nurse made sure that the ventilator was set at low-tidal volume and consistently assessed the patient's response to treatment.

Conclusion

Research conducted from the past few decades have demonstrated extensive efforts in improving the management of ARDS. While there is no cure for this condition, the goal of ARDS treatment is to provide supportive care, target the underlying cause, and correct hypoxemia. Currently, there are several evidence-based practices that may effectively improve outcomes in patient with ARDS, including lung-protective ventilation, prone positioning, and conservative fluid management. Although advancements in treatment have substantially increased the survival rate of these patients, ARDS remains to be a leading cause of mortality in the critical care setting. Therefore, further research is warranted to refine the current treatment protocol and explore new direction of therapeutic strategies.

References

Ambati, S., & Yandrapalli, S. (2020). Refractory Hypoxemia and Venovenous ECMO. *StatPearls. https://www.ncbi.nlm.nih.gov/books/NBK560516/*

Casey, J. D., Semler, M. W., & Rice, T. W. (2019). Fluid management in acute respiratory distress syndrome. *Seminars In Respiratory and Critical Care Medicine, 40*(1), 57-65. http://doi.org/10.1055/s-0039-1685206

Fan, E., Del Sorbo, L., Goligher, E. C., Hodgson, C. L., Munshi, L., Walkey, A. J., ... & Brochard, L. J. (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. https://doi.org/10.1164/rccm.201703-0548ST

Fan, E., Brodie, D., & Slutsky, A. S. (2018). Acute respiratory distress syndrome: advances in diagnosis and treatment. *JAMA*, *319*(7), 698-710. http://doi.org/10.1001/jama.2017.21907

Hafiz, M., & Stahl, J. (2019). Lung-protective Ventilation for Acute Respiratory Distress Syndrome. *Academic Emergency Medicine*, *26*(1), 109-112. https://doi.org/10.1111/acem.13648

Harding, M. M., Kwong, J., Roberts, D., Hagler, D., & Reinisch, C. (2019). *Lewis's medical-surgical nursing: Assessment and management of clinical problems.* Elsevier Health Sciences.

Lucchini, A., Bambi, S., Mattiussi, E., Elli, S., Villa, L., Bondi, H., ... & Foti, G. (2020). Prone position in acute respiratory distress syndrome patients: a retrospective analysis of complications. *Dimensions of Critical Care Nursing, 39*(1), 39-46. http://doi.org/ 10.1097/DCC.0000000000000393

Mitchell, D. A., & Seckel, M. A. (2018). Acute respiratory distress syndrome and prone positioning. *AACN Advanced Critical Care*, *29*(4), 415-425. https://doi.org/10.4037/aacnacc2018161

Saguil, A., & Fargo, M. V. (2012). Acute respiratory distress syndrome: diagnosis and management. *American Family Physician*, *85*(4), 352-358. https://www.aafp.org/afp/2020/0615/p730.html

Siegel, M. D., Siemieniuk, R., Parsons, P. E., & Guyatt, G. (2020). Acute respiratory distress syndrome: supportive care and oxygenation in adults. *UpToDate. https://www.uptodate.com/contents/acute-respiratory-distress-syndrome-supportive-care-and-oxygenation-in-adults/print*

Thompson, B. T., Chambers, R. C., & Liu, K. D. (2017). Acute respiratory distress syndrome. *New England Journal of Medicine*, *377*(6), 562-572. http://doi.org/10.1056/NEJMra1608077

Zayed, Y., & Askari, R. (2020). Respiratory distress syndrome. *StatPearls*. https://www.ncbi.nlm.nih.gov/books/NBK538311/