Acute Respiratory Distress Syndrome (ARDS): The Critical Care Patient and Nursing Management

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In the United States, an estimated 200,000 patients are affected with acute respiratory distress syndrome (ARDS) each year, and the mortality rate among patients with severe ARDS is 45% (Ryan et al., 2021). It is one of the most common diagnoses seen in the intensive care unit (ICU), and indeed, in her previous ICU rotation, the author had the opportunity to care for a patient with moderate-to-severe ARDS. This paper will present a short case study describing the patient's situation, followed by a discussion of the disease process and the existing evidence-based practices, highlighting those that have actually been applied to the care of the patient, and finally, some QSEN competencies that were observed during the rotation.

Case Study

G.H. is a 63-year-old Caucasian male patient with a history of right-sided hemiparesis from a motor vehicle accident 45 years ago, who was brought to the emergency department one evening after having had an unwitnessed fall from the bed and altered mental status. He was afebrile and hemodynamically stable, but laboratory tests showed thrombocytopenia, hypokalemia, and positive antigen for Covid-19. G.H. was admitted to the med-surg unit where his breathing progressively deteriorated despite use of BIPAP. He was transferred to the ICU after a few days and was placed on continuous mandatory ventilation CMV. A provider ordered proning, which was discontinued by another provider after a week of seeing no improvement on G.H.'s respiratory status. He also developed a couple of pressure injuries on his face from proning. Back to semi-Fowler's, G.H.'s PaO2/FiO2 continued to hold below 200. His O2 dropped to low 70's at around 4pm when he was repositioned which woke him up and so he started holding his breath and was going out of sync with the ventilator. He was given midazolam 1g and his FiO2 was increased to 65 from 60 and RT was informed of the change. After a few minutes, his SPO2 came back up to 94%

Pathophysiology

Acute respiratory distress syndrome (ARDS) is a sudden and progressive form of acute respiratory failure in which the alveolar-capillary membrane becomes damaged and more permeable to intravascular fluid. It is a syndrome, not a disease, as it is not standalone and is associated with many conditions which are caused by either direct or indirect injuries. In ARDS, the alveoli and the capillaries that surround them - the site of gas exchange in the lungs - are damaged by an inflammatory process like pneumonia or sepsis (Harding et.al., 2020). As a result of this inflammation, blood becomes more likely to clot. The endothelium also becomes leaky, allowing fluid to seep into the interstitium, causing pulmonary edema, and the fluid then seeps into the alveoli—causing an infiltrate to show up on a chest X-ray. . Further, the alveoli themselves get injured and they are not able to do a good job with facilitating gas exchange and produce less surfactant. Without surfactant, there's more surface tension within the alveoli and that makes them more likely to collapse.

ARDS is generally a severe and often life-threatening situation that starts with shortness of breath hours after the initial alveolar injury occurs and then rapidly worsens to the point of respiratory failure. In 2011, experts from Europe and North America convened and developed the Berlin Definition of ARDS (JAMA, 2012) whereby a person in respiratory distress is diagnosed with ARDS if they meet these 4 criteria: First, the symptoms have to be present within 1 week of known clinical insult or if there's new or worsening respiratory symptoms. Second, a chest X-Ray or CT scan shows opacities—or "white out"—in both lungs, which is due to the massive pulmonary edema that develop in ARDS. The third relates to what's called the PF ratio, which is the partial pressure of oxygen in the arterial blood (PaO2) divided by the percent of oxygen in the inspired air, also called the fraction of inspired oxygen (FiO2) (Harding et.al.,

2020). In ARDS, the PF ratio is below 300 mmHg, and the lower this ratio gets, the more severe the ARDS is. The fourth criterion is that the respiratory distress must not be caused by cardiogenic failure as opposed to the pulmonary edema from ARDS as these 2 conditions are managed differently.

Clinical Concepts

To treat ARDS effectively, a care provider has to understand what's going on with the patient and to do this, it is important to have solid knowledge on many ICU-specific and ventilation-specific concepts. One of them that is critical to ARDS is P/F ratio, which is the ratio of arterial oxygen partial pressure (PaO2 in mmHg or P) to fractional inspired oxygen (FiO2 or F). P/F ratio is a clinical indicator of hypoxemia, which is a condition where there is lack of oxygen in the blood (Harding et al., 2020). Hypoxemia is stratified from mild, moderate, and severe based on the P/F ratio and PEEP. Positive end-expiratory pressure (PEEP) is the constant amount of pressure coming off the ventilator that keeps the alveoli open during expiration. Mechanical ventilators deliver a certain amount of air to the lungs with each "breath", and this is what tidal volume (TV) is (Harding et al, 2020). Vollman (2017) discussed how mechanical ventilators themselves can trigger RDS via direct injury to the lungs. Such is the case with *volutrauma*, caused by high tidal volumes, *barotrauma*, caused by high PEEP settings, and the reverse of that which is *atelectrauma*, which happens when PEEP is too low that there isn't enough to keep the airways open. Another ventilator-induced injury is oxygen toxicity which may be caused by high FiO2. Knowing the therapeutic ranges and limits of these settings is a crucial responsibility of not only the respiratory therapist but the nurses and physicians as well.

Nursing management

One of the key interventions when managing ARDS is continuous patient monitoring. Nurses are expected to calculate the P/F ratio frequently. A nurse can simply look up the notes of a respiratory therapist (RT) as they often are the ones primarily monitoring this in the ICU. Otherwise, they can calculate it themselves by dividing value of PaO2 by the FiO2. During the writer's ICU rotation, the nurses record the P/F ratio every 2 hours or so. Although it's mostly the RT's responsibility to keep track and change the settings on the ventilator, the nurses should take it upon themselves to be aware of the ordered settings and make sure the machine is set up correctly.

Sigel & Siemieniuk (2021) published a literature review of the supportive care that is being provided at present and much of the forms of care highlighted are pharmaceutical – administration and titration of sedative drugs, administration of glucocorticoids, neuro-muscular blocking agents (NMBA), nitrous oxide, and others, and while all these are helpful to some point, Kathleen Vollman, a clinical care nurse educator and consultant, argued that a care management should be highly nursing-managed. In her presentation of ARDS care management, she discussed the "8 Ps of ARDS treatment", as outlined by the Petal Network Research team (Vollman, 2017): prevention, PEEP, pump, pipes, paralysis, position, proning, protein, and protocol. For the purpose of this paper, the author will only discuss those that were applied in the care of patient G.H. during the actual clinical rotation. Prevention refers to ensuring that the settings of the mechanical ventilation are appropriate, with focus on PEEP and tidal volume (V_T). Because a higher ventilation is found to cause an injury like ARDS in a diseased lung (Smith & Shifrin, 2020), studies have recommended that V_T should be no more than 6 mL/kg of predicted body weight (PBW). G.H.'s V_T was 6.8 mL/kg, which was just a little more than what was recommended but the nurse could have discussed with the RT. 2 of the other "Ps" stand for

pumps and pipes which points to fluid management. G.H.'s IV infusion of 09% NaCl was slow and steady at 50 mL/hr**.** Balancing fluid administration is critical because too much may worsen the underlying pulmonary edema and too little, especially with an accompanying use of vasopressors, may lead to decreased cardiac output and pulmonary blood flow which will worsen hypoxemia (Keddissi et al., 2018). Another very important "P" is position. Vollman stated that the worst thing nurses can do for an ARDS patient is to leave them not moving because those "infiltrates" in their lungs become static which in turn worsen their V/Q (ventilation-perfusion) mismatch. It also showed a difference in preventing VAP (Kaur et al., 2021)**.** The nurses of G.H. made sure to reposition him every 2 hours.

There is a vast multitude of studies done on proning therapy which showed evidence that manual proning reduce mortality among moderate to severe ARDS patients and decrease their hospital length of stay. Prone positioning improves ventilation-perfusion matching and *alveolar recruitment* (which simply means the opening of collapsed alveoli), which leads to improved gas exchange and prevention of ventilator-induced lung injury (Ryan et al., 2021). Most of the established evidence were gathered from 16 hour-proning studies but there's an emerging number of studies that suggest that proning for 12 hours may be sufficient and may solve the problem with it being associated with higher rates of endotracheal tube obstruction or dislodgment and of pressure sores**.** In any case, nurses are in a critical position to make sure that these incidences do not happen by being more attentive and employing the assistance of other nurses when turning the patients. G.H.'s nurses did not seem to shift the head once every 8 hours and so G.H. had a couple of pressure sores on his face- one on his right cheek and one on the midline of his nose. The daytime nurse during the author's rotation placed adhesive foam dressings on them and also on the other bony areas that are prone to pressure sores like the

knees. Another aspect to the effectiveness of proning therapy is its timing. Proning is recommended as first-line therapy for moderate and severe ARDS and should be applied within 24-36 hours from ICU admission. Studies have shown that if proning is delayed then it's not going to be as useful because late ARDS represents the fibroproliferative phase and so the alveoli are less complaint. Therefore, the oxygenation response is superior in early ARDS patient than with late ARDS (Kaur et al., 2021). Unfortunately, the providers ordered proning for G.H. late. They only began proning G.H. 4 days after he was admitted to the ICU, and that was probably why his P/F ratio did not improve after days of pronation therapy.

QSEN concepts

Evidence-based practice

This paper emphasized the importance of proning therapy, a practice that is being applied as treatment more and more during the past decade and an innumerable amount of studies have been devoted to it in the U.K. and the U.S. Although the exact mechanism that results in oxygenation improvement is still being studied, there is irrefutable evidence of the benefits of this increasingly popular treatment protocol, which is now not only used in managing ARDS but other respiratory conditions like Covid-19 infection (Smith & Shifrin, 2020). Other therapeutic interventions also root from evidence-based practice, such as IV therapy, where isotonic solutions are used with low infusion rates. There is still ongoing debate on what the best type of isotonic solution to use, however. And although pharmacological treatment takes a backseat when it comes to ARDS, they are still indispensable. In the case of G.H. for example, who needed sedation to allow synchrony between the ventilator and his own breathing.

Safety

An intervention that demonstrated safety for patient G.H. was turning his head every 1 or 2 hours and placing adhesive foam pads on bony areas where more pressure is applied from being prone. Because he did develop the pressure sores on his face, it was obvious that this safe practice was not observed from the get-go. There should be a proning protocol bundle followed in the ICU and uploaded in the EMR. Another example of safe practice, and which takes team effort, was the continuous assessment of the patient for signs of *barotrauma* (crepitus from subcutaneous emphysema, altered chest excursions, asymmetric chest movements) and *volutrauma* (increased work of breathing, ventilator asynchrony, agitation). Early recognition is critical to prevention of further complications (Gulanick, 2021).

Teamwork and Collaboration

Managing ARDS is a multi-disciplinary effort and the nurse should use a team approach in planning care with the providers, respiratory therapists, dietitian, and other team members and that includes the patient, if able, as well as their family members. The accuracy and timeliness of assessments made by the nurse is crucial to the next steps prescribed by the doctor and is required for adjusting mechanical ventilation settings like FiO2 and PEEP appropriately. Nurses works with physical therapists for the patient's mobilization and a speech therapist for evaluating swallowing abilities when the patient is weaned off the ventilator. Family members play a role in providing care by informing the care team of the immobilized and verbally impaired patient's preferences and the care team should accommodate these into the patient's care as reasonably as possible.

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