Review

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Medical Management and Nursing Care of a Patient with Acute Respiratory Distress Syndrome

Akut Respiratuvar Distres Sendromlu Hastanın Tıbbi Yönetimi ve Hemşirelik Bakımı

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ABSTRACT

Acute respiratory distress syndrome (ARDS) is a critical, life-threatening condition involving both lungs, characterized by capillary endothelial damage, diffuse pulmonary infiltration, and oxygen-resistant hypoxemia. The incidence in intensive care units is between 7.1-12.5% and its mortality can be up to 40% in severe cases. Pathological processes with exudative, proliferative and fibrotic stages in the lungs in response to different etiological factors in ARDS result in hypoxemia, hypercapnia and decreased lung compliance. There is no drug with proven efficacy in treatment. The most crucial parameter of ARDS management is protective mechanical ventilation, including low tidal volume, high positive end-expiratory pressure regulations, prone position, and recruitment maneuvering. In addition, supportive approaches such as fluid management, nutritional support, reduction of oxygen consumption, prevention of ventilator-associated pneumonia, pain management, deep vein thrombosis prophylaxis, peptic ulcer prophylaxis, blood sugar regulation, and maintaining skin/tissue integrity are applied. This review will briefly describe ARDS and related factors, then focus on treatment, care, and patient follow-up from the physician and nurse perspective.

Keywords: Acute respiratory distress syndrome, ARDS, mechanical ventilation

ÖZ

Akut respiratuvar distres sendromu (ARDS) akut gelişen, her iki akciğeri içine alan, kapiller endotelyal hasar, yaygın pulmoner infiltrasyon ve oksijen tedavisine dirençli hipoksemi ile karekterize, yaşamı tehdit eden bir durumdur. Yoğun bakım ünitelerinde insidans 7,1-12,5 arasında olup, ciddi olgularda mortalite %40'lara kadar çıkabilmektedir. ARDS'de farklı etyolojik faktörlere yanıt olarak akciğerlerde oluşan eksüdatif, proliferatif ve fibrotik aşamaları olan patolojik süreçler hipoksemi, hiperkapni ve akciğer kompliyansında azalma ile sonuçlanır. ARDS tedavisinde etkinliği kanıtlanmış herhangi bir ilaç bulunmamaktadır. ARDS yönetiminde en önemli parametre düşük tidal volüm, yüksek PEEP düzenlemeleri, prone pozisyonu ve recruitment manevrasını içeren koruyucu mekanik ventilasyondur. Ek olarak sıvı yönetimi, beslenme desteği, oksijen tüketiminin azaltılması, ventilatör ilişkili pnomoninin önlenmesi, ağrı yönetimi, derin ven trombozu profilaksisi, peptik ülser profilaksisi, kan şekerinin regülasyonu ve deri/doku bütünlüğünün sürdürülmesi gibi destekleyici girişimler uygulanır. Bu derleme makalede ARDS ve ilişkili faktörler kısaca tanımlanacak, takiben hekim ve hemşire perspektifinden tedavi, bakım ve hasta izlemi konuları ele alınacaktır.

Anahtar Sözcükler: Akut solunum sıkıntısı sendromu, ARDS, mekanik ventilasyon

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Introduction

Acute respiratory distress syndrome (ARDS) is a life-threatening condition that involves both lungs, characterized by capillary endothelial damage, diffuse pulmonary infiltration, and oxygen-resistant hypoxemia (1).

From 1967, when it was first described as "ARDS" by Ausbaugh et al. (2), to the end of the 1980s, ARDS was called by various names such as shock lung, congestive atelectasis, post-perfusion lung, and traumatic wet lung (3).

In 1988, Murray et al. (4) developed the Lung Injury score, which was rated between 0 and 4 by using chest radiography, hypoxemia (PaO_2/FiO_2 ratio), positive end-expiratory pressure (PEEP) and ventilation and lung compliance; thereby, ARDS began to be diagnosed as a clinical syndrome (4).

In 1994, ARDS diagnostic criteria were revised at the American European Consensus Conference; finally, in 2012, the Berlin definition of ARDS was adopted in the literature. According to the Berlin definition, any patient with respiratory failure which develops or worsens in the last week, involves diffuse infiltration in both lungs, and cannot be explained by the presence of heart failure or fluid overload with a PaO_2/FiO_2 ratio below 300 is considered as ARDS (5). The severity of the clinical picture is classified as mild ARDS when 300≥ PaO_2/FiO_2 >200 (PEEP ≥5 cmH_20), as moderate ARDS when 200≥ PaO_2/FiO_2 >100 (PEEP ≥5 cmH_20), and as severe ARDS when PaO_2/FiO_2 ≤100 (PEEP ≥5 cmH_20) (6).

Study results on ARDS incidence differ considerably. Diagnosing ARDS requires evaluation of blood gases and chest radiography. The fact that routine accessibility of these examinations varies from country to country, from region to region, or from hospital to hospital is also reflected in the epidemiological study results. The incidence of ARDS in intensive care units (ICU) in Europe is between 7.1% and 12.5%. In a study conducted with 29,144 ICU patients from more than 50 countries, the prevalence of ARDS was 10.4%, and 23.4% of patients who underwent mechanical ventilation (MV) met the Berlin ARDS diagnostic criteria (7). ARDS is a health problem with significant consequences in terms of mortality and morbidity. Mortality can be up to 40% in patients with severe ARDS (7). Polyneuropathy, persistent muscle weakness, joint contractures, cognitive dysfunctions, post-traumatic stress disorder, and depression are common in patients who have survived with treatment, even after five years of discharge. Those problems negatively affect the quality of life of both the patient and the patient's family. In addition, ARDS has high costs to the households and the national economy due to the need for treatment in the ICUs and post-discharge expenses (8).

Many risk factors such as massive blood and plasma transfusion, intoxications, gas/smoke inhalation, sepsis, aspiration, lung infection, fat embolism, acute pancreatitis, major trauma play a role in the etiology of ARDS (9-11). It has been reported that chronic alcohol usage (12), passive smoking (13), and vitamin D deficiency (14) may increase ARDS susceptibility.

More than 40 genes such as angiotensin converter enzyme, pro-inflammatory interleukin (IL-1 B, IL-6, IL-8), anti-inflammatory molecule (IL-10), and tumor necrosis factor have been identified in the pathogenesis of ARDS (15,16). Although there are different etiological factors, the exact pathological response occurs in the lungs in ARDS is not known. The pathological process in ARDS includes exudative, proliferative and fibrotic stages. In the exudative phase, which is seen in the first 72 hours, edema is observed in the interstitium and alveolar area due to extensive alveolar damage (11). Fibrin formation and granulation start in the proliferative phase, which is generally observed between 4-10 days. In the fibrotic phase, fibrosis develops with collagen accumulation (1,11). Recovery takes months after the fibrotic stage (10). Various biological processes, especially inflammation, apoptosis, and thrombosis, play a role in the pathogenesis of ARDS. All these pathological processes result in hypoxemia, hypercapnia, and decreased lung compliance (1,10,11).

Treatment and Nursing Care

An individualized approach is the essential element in its treatment and nursing care. First of all, plans should be made to reduce existing lung damage and prevent further damage to the patient. ARDS management can be examined under three headings: MV, supportive approaches, and pharmacological treatment.

Mechanical Ventilation

The most significant parameter of ARDS management is MV. With the ventilator, both oxygenations are provided safely, and the ventilator undertakes the majority of increased respiratory load due to increased breathing requirement, decreased compliance, and increased alveolar dead space. Moreover, MV plays a role in reducing pulmonary edema as it decreases venous return to the heart (10,17).

However, it should be kept in mind that MV support may lead to lung damage and exacerbate existing lung damage (11). Therefore, volutrauma, barotrauma, and atelectrauma are tried to be prevented by following protective MV strategies (18,19), including low tidal volume (TV), high PEEP arrangements, prone position (PP), and recruitment maneuver (RM) practices (17).

With RM, also known as opening maneuvers for atelectasis, high pressure is applied to patients for a certain period at certain intervals after separating from the ventilator (11). Extracorporeal membrane oxygenation can be used when preventive MV strategies achieve no result in ARDS treatment (11).

Tidal volume should be adjusted to be 4-8 mL/patient's ideal weight (6). The collapse of the alveoli should be prevented by keeping the airway pressure above atmospheric pressure with a high PEEP value (minimum ≥5 cmH_2O) (11). The PEEP level should be explicitly titrated for the patient in a way that does not deteriorate hemodynamics and maintains FiO_2 at 60% or less and arterial oxygen saturation at >0.88, plateau pressure at <30 cmH_2O, and drive pressure [plateau pressure (PEEP) end-expiratory positive pressure)] at <15 cmH_2O, while PaO_2 should

be maintained at 55-85 mmHg or SpO_2 at 88-95%. Ventilation rate can be set up to 35/min and the ratio of inspiration/expiration should be 1:1 or 1:3 (6).

Patients with ARDS should be placed in the PP for at least 12 hours a day. PP acts synergistically with both TV and PEEP (20). Vital signs should be checked before PP is given with monitoring ensured by attaching electrocardiography electrodes. Eye pomade should be applied to prevent corneal abrasions, eyes should be covered with a sterile eye pad, and oxygenation should be provided with 100% FiO_2 for 10 minutes before giving PP. Intubation materials should be kept ready during PP administration against the possibility of extubation (21,22).

PP should be given with a team of at least five people. The patient's neck and spine should be supported during positioning, respiratory indicators (SpO_2, blood gas values, compliance with the ventilator, ventilator alarms, etc.) should be monitored, if negative changes in respiratory functions (<SpO_2: 88-90%, etc.) are detected, support should be called by pressing the emergency call button (22). The locations of the infusion pumps, hence their lengths, should be appropriately adjusted to prevent the tension of the catheters attached to the patient during the application (21).

Before the procedure, the level of pain sedation/agitation should be examined to ensure the patient's tolerance to PP. The need for additional sedation should be evaluated. If the patient develops ventilator incompatibility during the procedure, begins to wake up, and sudden deterioration is observed in the patient's general condition, the emergency response should be performed (21). When placing the patient back in the supine position, hemodynamic data and ventilation/perfusion ratio should be closely monitored (21,22).

Hemodynamic follow-up, including oxygen saturation, blood pressure, cardiac apex beat/nb, respiration, and body temperature, should be done in patients connected to the ventilator. High- and low-pressure alarm limits should be set specially for each patient and monitor alarms should not be silenced. They should be continuously audible even if the patient's condition is stable (22).

Intratracheal aspiration should not be performed in patients with ARDS unless it is needed. Because, every time the patient leaves the ventilation machine for aspiration, the enlarged alveoli collapse, and it takes time to reopen. Inflammation may also develop. The closed suction systems used in the patient do not provide any advantage in this regard. On the other hand, the closed system aspiration technique seems advantageous in preventing droplet and aerosol formation in terms of contamination risk during aspiration (21).

Supportive Approaches

Respiratory failure is the sole cause of mortality in very few patients with ARDS. Mortality is usually associated with the primary cause of ARDS, and the presence and association of secondary complications such as multiple organ failure and sepsis. Therefore, conditions that may affect mortality and morbidity, and lung interventions in patients with ARDS, should be controlled. Supportive approaches in ICU in general and in patients with ARDS, in particular, can be summarized as fluid management (23), nutritional support (22,24), reduction of oxygen consumption (25), prevention of ventilator-associated pneumonia (19,26,27), pain management (28,29,30), prevention of deep vein thrombosis (DVT) (31), peptic ulcer prophylaxis and bleeding control (32), providing glycemic control (33) and protecting and maintaining skin/tissue integrity (21,22,26).

Fluid Management

Fluid restriction in the early stages of ARDS may be beneficial in reducing pulmonary edema. However, it should be kept in mind that fluid restriction may reduce cardiac output and perfusion, thus exacerbating impaired oxygenation, which is already the main problem in ARDS. Therefore, the fluid regimen should be carefully planned according to the ARDS period. The patient's clinic and the fluid intake and removal should be monitored (23).

Nutritional Support

It is significant in patients with ARDS to switch to enteral or parenteral nutrition at an early stage by evaluating the gastrointestinal system. The European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines should be taken into consideration in assessing the nutritional parameters and determining the amount of energy and content needed (24).

Enteral feeding is started within the first 24 hours in patients who do not have gastrointestinal system (GIS) problems such as vomiting, peritonitis, paralytic ileus, etc. Enteral feeding can be administered by giving formula continuously (with an enteral infusion pump), intermittently (4x1 or 6x1 at intervals/day), or as a bolus (3x1 or 5x1/day with a gavage injector). In patients with enteral feeding, gastric residual volume control should be done every 4-6 hours, feeding bags should be filled to be finished in 6 hours, and no medication should be added to the formula. Parenteral feeding should be started if intolerance symptoms such as nausea, vomiting, gastric distension, high residual volume, and diarrhea develop in patients, if the daily calorie intake is insufficient, or if there are gastrointestinal problems such as peptic ulcer (22). In parenteral nutrition, the infusion should be started with a low amount (20 mL/hour), and the dose should be increased every 6 hours, considering the patient's tolerance (22).

Reduction of Oxygen Consumption

One of the vital supportive strategies in patients with ARDS is to reduce oxygen consumption. Increased oxygen consumption surges the amount of oxygen removed from the arterial blood, thus causing a decrease in the saturation of mixed venous blood returning to the lungs. Fever, pain, anxiety and active use of respiratory muscles significantly increase oxygen consumption. Therefore, it is vital to control the patients' fever and toprovide pain management, deep sedation, and analgesia (25).

Prevention of Ventilator-Associated Pneumonia

The VAP is one of the most common complications seen in patients ventilated. It is essential to apply handwashing protocols meticulously, raising the bed head (30-45°, especially in patients with enteral feeding), and performing oral care with chlorhexidine every 4-6 hours to prevent VAP in patients undergoing MV. When necessary, it is recommended to perform a tracheal aspiration, which will be administered to maintain airway patency in less than 15 seconds and take at least a 1-minute break for the second aspiration (19,26,27).

Pain Management

Pain experience is known to be common in ICU patients. These patients may experience pain for many reasons, such as an endotracheal tube, drain insertion/removal, bladder catheterization, CVC catheter application, positioning and immobility, and existing health problems (28). In addition, physical and psychological factors such as being in an ICU environment, anxiety, and fear of death due to dyspnea, can increase pain perception (29).

Pain may exacerbate ARDS by causing the release of endogenous metabolites, hyper-metabolic activity, increased myocardial oxygen consumption, myocardial ischemia, and pulmonary dysfunction. Hence, it is significant to evaluate and manage pain with appropriate scales in patients with ARDS (29).

Initially, the source of pain should be investigated in the patient. If the patient is conscious, it should be questioned whether the diagnosis and treatment attempts have caused pain. If there is pain, its severity should be determined. If the patient has difficulty in speaking or if data collection is desired without exhausting the patient and with consuming minimum oxygen, as in ARDS, the patient may be asked to answer the questions with short answers as "yes" and "no" or by opening and closing her/his eyes. Using a standard scale for pain assessment is helpful for comparing raters, but the scales should be as short as possible (28,29,30).

Pain can be evaluated with behavioral (clenching teeth, clenching fists, frowning, and crying) and physiological symptoms (increase-decrease in respiratory rate, nausea-vomiting, sweating, and decrease in saturation) in patients who are unconscious due to sedation or MV, or who have changes in consciousness. For this purpose, scales such as "Non-Verbal Pain Scale for Adults," "Pain Observation Scale in Intensive Care," "Ramsay Sedation Scale," "Pain Diagnosis and Intervention Form," and "Motor Movement Rating Scale" can be used. Respiratory distress experienced in ARDS may also be reflected in the physiological symptoms of pain; hence, the evaluation should be done carefully. It is best to assess the pain as soon as the patient comes to the ICU unit, followed by an assessment every 8 hours if there is no pain, 2 hours for mild pain, hourly for moderate pain, and every half hour for severe pain (29,30).

DVT Prophylaxis

Deep vein thrombosis can develop asymptomatically in ICU patients. MV, various catheters, and immobility can increase DVT risk. It is recommended to evaluate patients in terms of venous thrombosis and apply primary DVT prophylaxis (such as unfractionated heparin, low molecular weight heparin, fondaparinux, and warfarin) in risky patients. In addition to anticoagulant therapy, mechanical protective methods such as elastic stockings and intermittent pneumatic compression can be applied (31).

Peptic Ulcer Prophylaxis and Bleeding Control

Peptic ulcers, which are common in ICU patients, are caused by increased corticosteroids released in response to stress, decreased bicarbonate release, and reduced gastric blood flow. Peptic ulcer increases the risk of GIS bleeding. Therefore, peptic ulcer prophylaxis is performed with proton pump inhibitors or H2 receptor blockers in ICU patients. Patients should be monitored regularly in terms of bleeding. Cannula insertion points should be checked routinely in terms of hematoma and urine color should be checked routinely in terms of hematuria. Anticoagulation doses should be adjusted by regularly evaluating blood gas values and bleeding findings (32).

Blood Sugar Regulation

Stress-induced cortisol and cytokines increase hepatic gluconeogenesis, disrupt glucose utilization, and cause insulin insufficiency. If the patient has diabetes, not giving anti-diabetics that the patient have previously taken, using corticosteroids, and enteral/parenteral nutrition contribute to hyperglycemia. Uncontrolled hyperglycemia in ICU patients is directly related to mortality and morbidity, especially infection. For these reasons, it is essential to ensure optimal glucose control. However, glucose control should be adjusted so as not to cause hypoglycemia. The American Diabetes Association recommends checking HbA1C in all hospitalized diabetic patients, in critically ill patients if they have not been examined in the last three months, or patients with hyperglycemia (blood glucose >140 mg/dL), and initiating insulin therapy according to standard protocols. When blood sugar is ≥180 mg/dL, insulin therapy should be adjusted to keep blood sugar within the limits of 140-180 mg/dL to prevent kidney damage. Lower blood glucose levels can be aimed at patients with a low risk of hypoglycemia (110-140 mg/dL) (33).

Protecting and Maintaining Skin/Tissue Integrity

For the dried crusts, residues around the eyes are softened by keeping the gauze soaked with warm water on the eyelid for a while. The eye should be cleaned by wiping from the inner part towards the outer part with a sterile sponge. Eye pomade should be applied before PP to prevent corneal abrasions. Eyes should be covered with a sterile eye pad (22).

During positioning, the patient's spine, especially the neck and waist, should be supported (21). In preventing pressure sores, a position change should be made every 2 hours, pressure zones should be supported, the pressure exerted by the catheters should be checked, and necessary measures should be taken (22). In patients given PP, the facial area should be checked for pressure and edema and routine pressure zones (21). In keeping the skin dry and clean, it should be cleansed and moisturized following

the protocols. Oral care should be done with chlorhexidine to prevent dry mouth and mucositis, and lips should be moistened (22,26).

Pharmacological Treatment

Except for neuromuscular blockers, which facilitate ventilator compliance and reduce the need for ventilation by slowing down metabolism, there is no drug with proven efficacy in ARDS. If there is an infection in the etiology of ARDS, antibiotic treatment is applied (34). Sedation and analgesia are beneficial insofar as they increase MV tolerance and reduce oxygen consumption (18). Although their routine usage is not recommended, inhaled nitric oxide is helpful by selectively decreasing pulmonary vascular resistance, performing pulmonary vasodilation, increasing oxygenation in well-ventilated lung areas, and decreasing pulmonary edema (11). The usage of corticosteroids in patients with ARDS is controversial, and it is recommended that patients using corticosteroids should be followed up for infection (35).

Conclusion

Although many risk factors for ARDS have been identified, there is no clear strategy for prevention so far. It is known that the only treatment method that reduces mortality in the management of the clinical picture is low TV + limited plateau pressure. Therefore, the importance of awareness, early diagnosis, early intervention with an integrated approach, and good clinical follow-up cannot be denied in ARDS prognosis.

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