Acute Respiratory Distress Syndrome

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Introduction

The onset of acute respiratory distress syndrome occurs as a result of previous trauma, stress, or shock. It can occur because of numerous direct or indirect causes (1). Often, complications in diagnosis and treatment can arise due to the nonspecific nature of ARDS. ARDS patients will require mechanical ventilation to assist breathing along with enteral nutrition until underlying causes can be treated and normal respiratory function can be restored. Possibilities of decreased quality of life and subsequent mortality are determined based on each patient's individual circumstances.

Disease Description

Acute respiratory distress syndrome (ARDS) is defined as a sudden dysfunction in the respiratory system. It is clinically defined as a PaO2/FiO2 less than 200 mmHg. This means the fraction of inspired oxygen is significantly lower than in a healthy individual. Within the past two years, this definition has expanded. Mild (<300 mmHg), moderate (<200 mmHg), and severe (<100 mmHg) are now newly acquired terms associated with ARDS in hopes to remove the term "acute lung injury". These newly defined classifications have been found to be better predictors of mortality within individual patients (2).

Pulmonary edema is another characteristic seen in patients with ARDS. Edema within the lungs increases the distance oxygen needs to take in order to enter the blood stream from the lungs. This results in labored breathing and an overall hypoxic effect throughout the body. Once the alveoli have become primarily filled with fluid, the blood passing by can no longer become oxygenated resulting in intrapulmonary shunting (3). A lack of oxygen within the body leads to possible organ damaged resulting in a decreased quality of life discussed later.

Possible causes of ARDS have such a wide variety that it is difficult to determine the exact

incidence of this syndrome throughout the World. In the United States, 64 cases occur for every 100,000 individuals based on one prospective study (4). However, throughout the World it is estimated that 1.5 to 75 cases occur for every 100,000 individuals. Over the past 23 years, the incidence of ARDS has been increasing. As of 2008, approximately 25-40 % of these cases end in death (5). Throughout the recent years, the mortality rate of those diagnosed with ARDS is decreasing through new medical interventions and earlier diagnosis.

Etiology

Risk factors

A widespread infection in the blood stream is one of the most prominent risk factors for developing ARDS (6). Surprising however, patients with diabetes have been found to have half the risk of developing ARDS compared to patients without diabetes. This occurs because of the effect diabetes has on the immune system. Patients with diabetes will have defects in neutrophil function which can lead to a decrease in oxidative damage (7).

In terms of increased risk of mortality, the biggest risk factors include old age, shock and liver failure (5). Those who have fewer chronic diseases and are of a young age, have an increased risk of survival.

Pathophysiology and Course of the Disease

There are two main phases during the course of the disease. The early phase is known as an exudative state. This means that the permeability between the alveoli and the capillaries becomes weaker and fluid is able to cross into the alveoli (8). Acute inflammation occurs as pro-inflammatory cytokines and neutrophils are released because of impaired endothelial cell barrier function. A patient will experience respiratory failure because of the fluid-filled air spaces and decreased surfactant production (9). This stage occurs quickly after the primary cause of ARDS

begins in the body. Most patients will survive this stage of ARDS; however, further damage often occurs.

The second stage of ARDS is known as the fibroproliferative phase. This stage can also be described as pulmonary fibrosis or scarring of the lung. This stage begins with proliferation of type 2 pneumocytes and thickening of the alveolar capillaries. Development of increased collagen deposition, longer period of ventilation, and overall diminished lung capacity are the final stages in this step (9). In this stage, an individual's prognosis becomes even poorer. Out of the deaths cause by ARDS, 55% occurred because of pulmonary fibrosis (10). When determining a patient's prognosis, finding fibrosis within the lungs is often a good indicator of the severity of the disease.

Methods of Medical Diagnosis

Because there are many nonspecific characteristics of ARDS, it can often be difficult to diagnosis in patients. Interestingly, only 48% of patients with autopsy-proven ARDS were diagnosed before death in their medical records (11). ARDS is often unrecognized in patients.

In order to properly diagnosis ARDS from its various causes, it is important to understand how to rule out other syndromes. The previous term, acute lung injury, is a step below ARDS in terms of severity. If a patient has a PaO2/FiO2 ratio of <300 mmHg, they are diagnosed with acute lung injury or mild ARDS unless the degree of hypoxia decreases to a level below 200 mmHg. Heart failure can also be ruled out of possible diagnosis by assessing left heart function (12).

When giving a patient an auscultation examination, crackle sounds will be present because of inappropriate fluid in the lungs. This assessment is typically done in the ICU. ARDS is typically diagnosed in a patient who is critically ill from trauma such as sepsis or shock. The signs and

symptoms of ARDS usually begin to occur one to two days after the patient's initial injury. The patient will have shortness of breath, overall difficulty in breathing, rapid breathing, and low blood pressure (6). However, further medical screening and examinations need to take place to further diagnosis the disease. Chest-imaging studies, echocardiography, right-heart catheterization, and bronchoscopy are all tools useful in diagnosis ARDS. Lung biopsy can be a potential diagnostic tool as well; however, there is a high risk of complications and it is not the primary recommendation (9).

Current Medical Therapies

In order to help a patient with ARDS, admittance to the ICU is essential. While in the ICU, it is the medical team's goal to provide the patient with oxygen while treating the cause of ARDS. In order to provide the patient with adequate oxygen, ventilators are used to sustain life while treating the underlying cause of ARDS. Those with this syndrome have decreased lung compliance and the ventilator will have to work at a force strong enough to be able to achieve the sufficient oxygen volume in the patient.

A ventilator is used in patients with ARDS by an endotracheal tube inserted down the patient's windpipe. Although a ventilator is placed to assist a patient with breathing, it is recommended to be used only for the minimal amount of time needed to help the patient recover to an improved lung function (13). This is because ventilators often come with increased complications. Too much pressure can cause air to leak into the space between the chest and lungs resulting in pneumothorax, overall lung damage, and even reach a level of lung toxicity. There are also possibilities of damage resulting from the effect of the physical breathing tube. Vocal cords are often damaged because of the placement of the breathing tube leaving patients with an inability to speak and breathe properly as they had prior (14). The amount of forced

airflow and placement of breathing tubes should be monitored by the medical team in order to prevent these circumstances.

More pressure is not however, the best option. One Cochrane review studied this issue. Researchers studied the comparison between low and conventional tidal volume in ventilation and any possible protective impact on patients. Barotramua occurs when the alveoli rupture because of excessive pressure exerted within the lungs. After understand the physiology occurring in the lungs, a lower tidal volume may lead to beneficial results. In addition to this possible protective effect, a lower tidal volume is associated with a lower inflammatory response which would help the goal of treating the cause of ARDS. They concluded with findings not strong enough to fully promote low tidal volume as the strongest form of ventilation for patients with ARDS because of the high levels of CO2 that remain in the patient's blood stream due to inadequate elimination (12).

Currently, there are no pharmacological treatments for ARDS that have significant beneficial results (15). It has been thought that early administration of corticosteroids to septic patients will help in the prevention of ARDS; however, this association remains weak (8). Because of the increased need to help those with ARDS, current research is being conducted to find possible treatment plans through pharmacological means.

Nutrition Assessment

Patients with ARDS are experiencing a hypermetabolic and hypercatabolic state. As with most diseases, overfeeding will result in undesired effects therefore calorie intake should be monitored by a registered dietitian. Protein requirements for ARDS patients are high and should be calculated within 1.5-2 g/kg depending on further unique complications. In order to assess protein levels, urea nitrogen can be monitored for further nutrition assessment. Weight changes

are critical in helping assess nutrition statuses of patients with ARDS. In assessing fluid requirements or restrictions, normal fluid intake is primarily used unless underlying conditions require otherwise (3).

If a patient is experiencing the beginning symptoms of ARDS, a likely PES statement would be categorized as "inadequate intake related to fair appetite as evidenced by low BMI and breathing complications."

Medical Nutrition Therapy

ARDS is part of further underlying conditions such as sepsis, shock, or trauma. Therefore, those with ARDS are at risk of malnutrition because of the increase need for energy due to the body's stress response. Nutrition support should begin quickly after the onset of ARDS to help the patient progress to a recovery as smoothly as possible.

Nutrition support will be required in ARDS patients because their oral intake will be inhibited due to mechanical ventilation to support breathing. Individuals with ARDS will have increased levels of arachodonic acid derived inflammatory mediators within their system highlighting a need for anti-inflammatory properties. In opposition to most patients' needs in the ICU, omega-3 is recommended for its anti-inflammatory nature and should be included within the patient's enteral formula during ventilation (3). During a study comparing traditional pulmonary formula to a formula high in omega-3 and antioxidants, patients who received the enhanced formula had improved oxygenation within less than a week—decreasing their length of ventilation (16). This formula however, is not associated with decreased mortality. Timing of the introduction of enteral nutrition does play a critical role in decreased mortality and introduction of nutrition support within 24 is encouraged (17).

According to the Nutrition Care Manual (3), there are two main nutrition goals for

patients with ARDS in the ICU. The first goal is to provide adequate energy and protein requirements through enteral nutrition in order to prevent weight loss. As most patients require a ventilator to provide oxygen throughout their bodies, these patients will lack the ability to consume energy orally, thus calling the need for eternal nutrition. Malnutrition is a major concern because of the potential threat it can place on the respiratory system. Malnutrition leads to decreased immunity while can lead to further infections and improper healing of the body. It will lead to decreased lung abilities in function, strength, and endurance (18). Proper nutrition is essential in order to provide the body will the adequate nutrients it needs to help heal and return to normal function.

Once the cause of ARDS has begun treatment and proper breathing function has returned, the medical team should move on towards the second nutritional goal for the patient. Secondly, after removal of the ventilator, the dietitian should aim to transition the patient to a high-calorie and high-protein diet to allow for enough energy for health improvement (3).

Long Term Prognosis

Those who survive ARDS will have lasting damage to their lungs or various other organs effected due to a lack of oxygen from the presence of ARDS. These effects lead to a decreased quality of life. Pulmonary insufficiency often remains. However, recent research suggests there is potential to improve. One study sought to search the impact ARDS had on patients diagnosed one year after their initial diagnosis. During their stay in the ICU, most had lost approximately 18% of their typical body weight. Approximately 70% of these same patients had returned to their usual body weight after one year; however, all of these individuals reported poor function of muscle, overall weakness, and fatigue that affected them in their daily activities. Interestingly, they found that pulmonary function returned to normal or near normal at approximately six

months because the most post-damage occurred due to a previous lack of oxygen throughout the body. Muscle weakness is the most common complication that decreases quality of life for the patients studied. Patients were also seen to have alopecia—or patches of lost hair—up until six months after diagnosis. Complaints of pain from where chest tubes were inserted were also noted to decrease quality of life. The last main effect of patients with ARDS is entrapment neuropathy (19). Entrapment neuropathy occurs when a nerve is pitched by a direct pressure resulting in numbness to a specific area of the body resulting to the noted muscle weakness. Overall, patients who have survived ARDS after one year were recognized to have improvements, but none were able to achieve their physical health they once had.

Alternative Therapy

With the risks of ventilation causing possible further complications, alternative therapy for assisted breathing has recently gained research. ARDS patients need mechanical ventilation to survive; however, complications of ventilation therapy can increase mortality. A new system called the Hemolung Respiratory Assist System (ALung) aims to decrease the risks associated with mechanical ventilation as well as proper CO2 removal that is not possible with a low tidal volume mechanical respiration system. Its mechanism is similar to the principles performed in renal dialysis. ALung will remove blood from the body and then return the blood back into circulation by removing CO2 from the blood and replacing it with O2. Since this is a new form of therapy, it requires more clinical trials before it becomes completely reliable in patients with ARDS. While the US has not approved it yet, Canada, Europe, and Australia have approved its function (20).

Summary

ARDS is a common syndrome within the ICU; however, it can be easily diagnosed as

another disease because of the wide variety in ARDS symptoms, causes, and close relationship to other pulmonary malfunctions. Medical treatment is limited from pharmacological means and currently relies on mechanical ventilation while the medical team treats the underlying causes. Nutrition support will be required in patients with ARDS because of a lack of access for oral consumption. Patients who receive formula high in omega-3 and antioxidants are helpful in reducing the length of ventilation for patients, but do not play a role in the risk of mortality overall.

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