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Clinical Case of Surfactant Administration in Adult Patient with COVID-19 Associated Pneumonia and Severe Acute Respiratory Distress Syndrome

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Abstract

First cases of COVID-19 appeared in Kazakhstan at the end of March 2020, which was significantly later than in other countries of Asia and Europe. We report on one of the first Kazakhstani patients with severe COVID-19. A 60-year old Caucasian man was hospitalized to the infectious department of Semey city hospital with the symptoms of fever up to 38.5°C, sore throat, general fatigue, scanty cough. The disease started abruptly and the patient was on self-administered antibiotics and aspirin within 4 days with no improvement.

Keywords: COVID-19 • Symptoms • Patient • Antibiotics • Microangiopathy

Introduction

Patients hospitalized with COVID-19 have severe respiratory symptoms resembling ARDS. Despite numerous trials and pharmaceutical regimens, no treatment has emerged as notably effective in the treatment of individuals with severe respiratory failure caused by COVID-19, while certain medications have showed early promise. It is has been observed that COVID-19 patients with severe respiratory distress can present with an atypical form of ARDS, exhibiting significant discrepancy between their severe hypoxemia and their relatively preserved lung mechanics. This pattern is more akin to neonatal Respiratory Distress Syndrome (RDS) caused by a lack of surfactant, which has been found to benefit by exogenous surfactant. We discuss our experience with exogenous surfactant treatment in a COVID-19 patient who was having respiratory failure.

Globally, the SARS-CoV-2 related disease (COVID-19) has significantly increased mortality. Hospitalised individuals frequently have bilateral pneumonia and 15% of them end up with ARDS. Similar to other viral pneumonias, COVID-19 causes broad alveolar damage at first. This is subsequently followed by specific angiocentric characteristics, including severe endothelial destruction, microangiopathy and blockage of alveolar capillaries. Clinically, this COVID-19 profile meets the requirements for ARDS, but it differs in key ways, such as having severe hypoxemia coupled with close to normal respiratory system compliance [1].

As a result, two distinct "phenotypes" of ARDS associated with COVID-19 have been discovered. Patients who are in the early stages of the disease (Type L: Low) have almost normal compliance, a low ventilation-to-perfusion (VA/Q) ratio, low lung weight, and a low lung recruitability. Patients later exhibit right-to-left shunting, high lung weight, and high lung recruitability (Type H: High) [2]. Both Ventilator-Induced Lung Damage (VILI) and viral pneumonia, which progressively gets worse, are likely to cause the transition between the two phenotypes. According to recent clinical evidence, type L patients should be handled with lower Positive End-Expiratory Pressure (PEEP), somewhat higher tidal volume (8 ml/kg-9 ml/kg), and prone positioning. Type H should be treated as severe ARDS, which includes extracorporeal support, prone positioning, and greater PEEP [3].

Four days before his symptoms developed, the patient returned from Egypt, where he contacted foreign tourists with

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COVID-19. There were no comorbidities in past history apart from arterial hypertension. At the time of admission, his consciousness was clear and he was hypodynamic. Auscultation revealed weakening of vesicular breathing in the lower lobes with no wheezing, the respiratory rate was 19 breaths/min, and heart rate was 92 beats/min. PCR test for SARS-CoV-2 showed positive result. Chest X-ray demonstrated bilateral pneumonia [4].

Case Presentation

At the next day the patient was transferred to the intensive care department due to severe deterioration of general state that manifested by dropped saturation to 88%, progressive intoxication syndrome, and negative radiological dynamics. Within the following two days his dyspnea progressed to 30 breaths/min, and SpO_2 decreased to 61%. Acute respiratory distress syndrome was diagnosed and mechanical ventilation was started [5]. At the fourth treatment day his state further deteriorated and reached a critical level: SpO_2 50%, D-dimer constituted 4671.0 ng/ml, troponin I was 68.5 pg/ml, and CRP was 1300 mg/L. At interim epicrisis the patient was categorized as having confirmed COVID-19, severe bilateral viral-bacterial pneumonia, type III respiratory failure, Acute Respiratory Distress Syndrome (ARDS) (Figure 1).

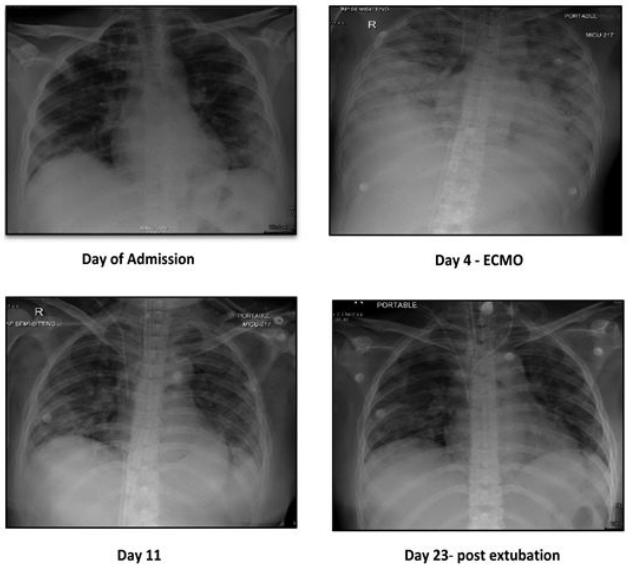

Figure 1. Management of life-threatening acute respiratory syndrome and severe pneumonia secondary to COVID-19 in pregnancy.

Because the patient did not improve after receiving azithromycin, hydroxychloroquine, and ceftriaxone, the azithromycin was changed with lopinavir/ritonavir. A repeat chest radiograph revealed increased bilateral opacities due to worsening respiratory status, the patient was transferred to the ICU and lopinavir/ritonavir was replaced with a single dose of tocilizumab. Despite noninvasive respiratory support, he continued to desaturate and was intubated on day 3 of his stay and placed on the ARDS treatment, which included extended proning.

Results and Discussion

The treatment included antiviral therapy (Lopinavir 400 mg/Ritonavir 100 mg), human normal immunoglobulin, antibiotics (Meropenem, vancomycin, azythromycin), antifungals, infusion therapy, dexamethasone 8 mg 4 times daily within 3 days, ascorbic acid intravenously 1.5 g daily, fraxiparin 0.4 subcutaneously 2 times daily, tracheobronchial lavage, administration of 30% alcohol solution via a nebulizer, parenteral nutrition and vibroacoustic massage [6]. Curosurf at a dose of 120 mg was administered *via* intubation 2 times daily (4 times altogether) with subsequent continuous aerosol administration within next 5 days in a dose of 30 mg/h-75 mg/h. At the next day after administration of curosurf was started, SpO_2 improved to 80% and continued to increase gradually. At the eighth day of treatment a patient had clear consciousness and stable vital signs and was extubated as his respiratory rate improved to 22 breaths/min and his heart rate was 86 beats/min, and SpO_2 was 96%. Also, there was positive radiological dynamics, which was characterized by decreased intensity and size of infiltration foci [7]. PCR became negative after 20 days of treatment, the patient's general state significantly improved and positive dynamics in clinical and laboratory parameters was observed. The patient was discharged at the thirtieth day of treatment. It is a well-known fact that both pneumonia and mechanical ventilation lead to the lung damage, which is associated with increased mortality rate and this consideration requires a search of mitigation strategies [8].

This particular patient was treated according to the international guidelines and Kazakhstani standards for COVID-19 management. However, he additionally received a surfactant therapy that was previously administered predominantly endotracheally in premature children with acute respiratory distress syndrome. Lung surfactant is being produced by alveolar pneumocytes and presents a surface-active substance consisting of lipids and proteins. With severe inflammation, cytokines inhibit the production of lipids and surfactant proteins [9,10].

Conclusion

There are only a limited number of studies on surfactant therapy in adults. It was proven that early initiation of surfactant therapy can quickly eliminate ARDS, improve blood oxygenation and significantly reduce associated mortality. A study based on the analysis of five multicenter clinical trials with 532 ARDS patients, of whom 266 were administered surfactant endotracheally, reported on significantly improved oxygenation in severe ARDS cases ($p=0.0008$) and increased survival ($p=0.018$). Besides, surfactant therapy is associated with improved concentration of unsaturated phospholipids, decrease in the percentage of neutrophils and increase in local pulmonary immunity. This clinical case reports on the first successful surfactant therapy in an adult patient with COVID-19 associated pneumonia and severe acute respiratory distress syndrome. There is a need to implement

randomized controlled clinical trials to evaluate surfactant effectiveness in this category of patients.

Author's Contribution

All authors cared for the patient and contributed to the manuscript.

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