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EXTRACORPOREAL MEMBRANE OXYGENATION FOR STATUS ASTHMATICUS: A CASE REPORT ECMO FOR STATUS ASTHMATICUS

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Abstract

Technological advances in extracorporeal membrane oxygenation and emerging evidence that it improves survival in adults with reversible respiratory failure compared to conventional ventilation has led to increased utilization of extracorporeal membrane oxygenation in adults, usually in the context of acute respiratory distress syndrome. Refractory status asthmaticus is an uncommon indication for extra-

corporeal membrane oxygenation. We present a case of near fatal respiratory failure and hypercapnia in a 48-year-old male in status asthmaticus not responsive to optimal ventilatory treatment. The use of veno-venous extracorporeal membrane oxygenation resulted in full recovery with return of normal respiratory function within nine days.

Keywords: *acute respiratory failure, bronchial asthma, extracorporeal membrane oxygenation.*

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Abbreviations:

ECMO - extracorporeal membrane oxygenation
PEEP - positive end-expiratory pressure

RR - respiratory rate

TV - tidal volume

V-V - veno-venous

Introduction

Status asthmaticus is an acute exacerbation of asthma that is unresponsive to repeated courses of beta-agonist therapy and is associated with signs or symptoms of potential respiratory failure. Mechanical ventilation for respiratory failure is currently the treatment of choice in severe cases of asthma, but is associated with increased in-hospital mortality compared with patients who do not require mechanical ventilation [1]. Ventilator strategies have been adopted to minimize complications such as barotrauma, dynamic hyperinflation and auto-positive end expiratory pressure but the new strategies have not eliminated these complications. In patients with ventilation-refractory hypercapnia and respiratory acidosis, extracorporeal membrane oxygenation (ECMO) may be an alternative ventilation strategy. Here we present our experience with veno-venous (V-V) ECMO for the treatment of hypercapnic respiratory failure in an adult male with severe refractory status asthmaticus.

Case Report

A 48-year-old man with past medical history significant for Human Immunodeficiency Virus (CD4 266 and viral load 215) presented to the ED with increasing dyspnea over two days. He had a known history of severe persistent asthma with frequent exacerbations including a recent admission requiring mechanical ventilation for 8 days. He reported compliance with his regular antiviral and asthma medications.

Upon presentation he was dyspneic and wheezing and tachycardic with heart rate of 104/min. He was not hypotensive or tachypneic and had arterial oxygenation of 98% on room air. Chest x-ray demonstrated hyperinflation. He was initially treated with oxygen therapy via 2 liters nasal cannula, nebulized ipratropium bromide and albuterol, methylprednisolone 125 mg, magnesium sulfate 2 g, ceftriaxone 1 g and azithromycin 500 mg. He was admitted to the hospital and maintained on nebulized ipratropium and albuterol q4 hours. On morning rounds patient was tachypneic with respiratory rate of 33/min and diffuse wheezing on exam with minimal air movement. His ipratropium bromide and albuterol treatments were increased to q2 hours. His arterial oxygen saturation was 97% on 2L nasal cannula but repeat arterial blood gas demonstrated carbon dioxide retention: pH 7.31 pCO₂ 45 mmHg, pO₂ 84 mmHg, HCO₃⁻ 22.7 mmol/L.

He was transferred to the MICU where he developed marked respiratory distress with accessory muscle use despite use of 30% non-rebreather mask. He received another dose of magnesium sulfate 2 mg and was started on heliox gas. He continued to maintain oxygen saturation over 90% but remained in respiratory distress with significant work of breathing. Oxygen therapy with non-invasive ventilator support via bipap at an inspiratory pressure of 15 and expiratory pressure of 4 was initiated. However, he remained tachypneic, became increasingly fatigued and was found to have worsening respiratory acidosis: pH 7.25, pCO₂ 54 mmHg, pO₂ 76 mmHg, HCO₃⁻ 23.7 mmol/L.



The patient was intubated and started on assist control mode ventilation, with respiratory rate (RR) of 20, tidal volume (TV) of 460 ml, FiO₂ 40%, I:E ratio of 1:2.5, and positive end-expiratory pressure (PEEP) of 0 cm H₂O. Adjunctive treatment with continuous nebulized ipratropium bromide and albuterol, aminophylline (500 mg), corticosteroid (60 mg q 6hr), and magnesium sulfate (2 mg q 6hr) were continued. Additionally, treatment with continuous ketamine (1 mg/kg/hr) and the inhalation anesthetic agent isoflurane was initiated. His condition continued to deteriorate with worsening hypercapnia: pH 7.15, pCO₂ 85 mmHg, pO₂ 115 mmHg, HCO₃⁻ 29.6 mmol/L.

Decision was made to initiate V-V ECMO for enhanced ventilation and carbon dioxide removal. This was performed on hospital day 6 via bi-femoral venous cannulation; right femoral to right atrium 25 cannula and left femoral cannula to inferior vena cava 23 cannula. Following the establishment of ECMO his blood gasses quickly improved. Values at 120 minutes after initiation of ECMO were: pH 7.33, pCO₂ 40 mmHg, pO₂ 62 mmHg, HCO₃⁻ 21.1 mmol/L. Ventilation was maintained on conventional mechanical mode, with RR of 10, TV of 250 ml, FiO₂ 40%, and PEEP of 15 mmHg. Rate of ECMO sweep gas flow was initiated at 8 L/min and slowly decreased to 3 L/min over the next 5 days. He was on continuous nebulized albuterol and Solumedrol 60 mg q6 hours, which was tapered down every 3 days. V-V ECMO was discontinued after 9 days of support and patient was extubated within 24 hours of ECMO cessation. His hospital course was complicated by acute kidney injury which did not require renal replacement therapy. He was discharged initially to a skilled nursing facility and then to home.

At 9 month follow up patient was doing well. He reported using his rescue inhaler 2-3 times per day and was tapering his prednisone from 20 mg/day to 10 mg/day.

Discussion

Patients with status asthmaticus who have progressive hypercapnia and or hypoxemia often require positive pressure ventilation, but status asthmaticus patients are usually already hyperinflated and have extremely high levels of airway pressure, which increases their risk of ventilator

barotrauma and is associated with substantial mortality [2].

ECMO has traditionally been used in infants and children with acute respiratory distress syndrome due to reversible pulmonary disease and as cardiac assistance in patients with circulatory failure [3]. In 1981, Kolobow published the first paper on extracorporeal carbon dioxide removal [4]. However, to date, ECMO is rarely used for the treatment of refractory status asthmaticus in adults. In a 2009 retrospective cohort registry review of the international Extracorporeal Life Support Organization Registry, among 1,257 patients treated with ECMO, only 24 (2%) were asthmatics. Yet, survival to discharge was much higher for the asthmatic group (83%) as compared to non-asthmatics (50.8%), even after adjustment for confounders [5].

Presently there are no evidence-based guidelines for initiating ECMO for status asthmaticus. Much of the evidence in support of its use in status asthmaticus is based on case reports with the reported indications in this group ranging from cardiovascular compromise, cardiac arrest, hypoxemia and shock, severe hypercapnia and acidosis, to dynamic hyperinflation [2,6,7].

Based on the results of their own experience with hypercapnic respiratory failure in three patients in status asthmaticus, Kukita et al. suggested a simple algorithm for initiation of ECMO: pH less than 7.2, PaCO₂ greater than 100 mm Hg, or life threatening conditions of hypoxemia, hypotension, or barotrauma in spite of optimization of ventilatory support [8]. Our patient fit these criteria. He had acute severe asthma, which did not improve despite maximum medical management and ventilator support. He continued to deteriorate and developed hypotension, hypercapnia and severe respiratory acidosis but returned to normal respiratory function within nine days after initiation of ECMO.

Conclusion

Our case report illustrates the effective use of ECMO in the face of impending cardiorespiratory collapse in a patient with severe respiratory failure due to refractory status asthmaticus.

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