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Cautious Use of Veno-Arterial Extracorporeal Membrane Oxygenation for MRSA Sepsis and Acute Respiratory Distress Syndrome

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Authors' contributions

This work was carried out in collaboration between all authors. Authors NC and HH designed the study. Author PH wrote the first draft of the manuscript. Authors PH and HH managed the literature searches. All authors read and approved the final manuscript.

Case Study

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ABSTRACT

Extracorporeal membrane oxygenation (ECMO) for septic shock has been reported occasionally and it has been shown to have reasonable outcomes in pediatrics cases. However, the adult ECMO for septic shock is not as clearly elucidated. Here we present a case of adult ECMO for septic shock secondary to MRSA, complicated by multi-organ abscesses. This case illustrates that MRSA sepsis is a major contraindication for the use of ECMO.

Keywords: ECMO; MRSA; ARDS; pneumonia.

1. INTRODUCTION

Extracorporeal membrane oxygenation (ECMO) is a form of extracorporeal life support by a modified heart-lung machine that was developed and first used to support an adult patient with refractory respiratory failure over 40 years ago. Since introduction, ECMO has become indispensable in the care of neonates and pediatric patients in the management of

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respiratory/cardiac failure secondary to a wide variety of diagnoses; however implementation of ECMO in the adult population has been limited.

Veno-arterial ECMO (VA ECMO) supports both cardiac and respiratory functions while veno-venous ECMO (VV ECMO) only supports respiratory function [1]. VA ECMO has been primarily used for profound cardiogenic shock as temporary mechanical circulatory support, aiming to wean a patient to recovery or bridging to implantable ventricular assist device placement. VA-ECMO requires both femoral arterial and venous cannulation and will provide full cardiopulmonary support. In contrast, VV ECMO requires a single cannula (specially designed double lumen cannula) placement into the right internal jugular vein, and it drains deoxygenated blood from superior and inferior vena cava and brings the oxygenated blood back to the right atrium facing the tricuspid valve [2]. Since VV ECMO requires native cardiac function to mix and circulate oxygenated blood, VV ECMO is best indicated for acute respiratory distress syndrome (ARDS) without cardiac dysfunction. If a patient present with both respiratory and cardiac dysfunction, the patient should be managed by VA-ECMO.

Currently, VA ECMO has been promoted as a mode of support for a selective population, such as septic pediatric patients that require cardiac support [3]. Nonetheless the use of ECMO in septic adults has not been studied in any depth. We present here an adult patient who suffered from acute respiratory distress syndrome, biventricular dysfunction, and evolving sepsis from unknown origin managed by VA-ECMO, which progressed into multiple organ failure and eventual mortality. At autopsy, we found the cause of the sepsis was due to overwhelming MRSA infection.

2. PRESENTATION OF CASE

A 39-year-old African American female presented with weakness, fever, respiratory distress two days after an endoscopic retrograde cholangiopancreatography for pancreatitis. The patient was immediately transferred to the ICU, and her condition quickly deteriorated. She required intubation, and developed severe hypotension requiring vasopressors. Blood and sputum cultures obtained at the time of admission were preliminary negative. Empirical broad-spectrum antibiotics (vancomycin and piperacillin/tazobactam) were initiated due to fever and hypotension. Cardiothoracic surgery was consulted for concern of the possible ECMO.

At the time of consultation, her temperature was 100.9° F, blood pressure was 97/68 mmHg, (mean blood pressure 78 mm Hg), and oxygen saturation was 91%. Arterial blood gas showed hypercapnia, hypoxia (pH 7.01, PaCO₂ 70, PaO₂ 70, HCO₃ 17 mmo/L with FiO₂ 100% with PEEP 15). She was in profound hypotension requiring 1 mic/kg/min of norepinephrine and intermittent bolus injection of epinephrine. Her urine output was 40-50 cc/h. Other laboratory values were as follows: White blood cell count (WBC) 4.5 B/L, hemoglobin 12.2 g/dL, creatinine 1.9 mg/dL, glucose 289 mg/dl, amylase 992 U/L, lipase 413 U/L, AST 38 IU/L, ALT 14 IU/L, and lactate 7.4 mmol/L. Echocardiography showed global biventricular dysfunction. Due to refractory ARDS, severe hypotension, and decreased ventricular function despite optimal medical treatment, VA-ECMO was initiated. The cause of hypotension was considered to be due to ongoing pancreatitis at the time of ECMO cannulation. The patient was stabilized on ECMO and her oxygen saturation improved. The arterial blood gas on VA-ECMO showed pH 7.45, PaCO₂ 33, PaO₂ 91 with ventilator FiO₂ 50% with PEEP 5 and ECMO FiO₂ 100% with sweep 8.0 LPM. She was weaned off vasopressors within 24 hours. Laboratory data 24 hours after ECMO initiation was as follows: WBC 13.7 B/L, hemoglobin 11.5 g/dL, creatinine 1.4 mg/dL, amylase 52 U/L,

lipase 18 U/L, AST 47 IU/L, ALT 19 IU/L, lactate 5.6 mmol/L. The patient was adequately perfused and vital signs were stabilized by ECMO.

On post-operative day 2, the blood and sputum cultures on the admission came back positive for methicillin resistant *Staphylococcus Aureus* (MRSA). Although the patient was placed on appropriate antibiotics coverage (vancomycin), the blood culture was persistently positive for MRSA; thus linezolid was added for the antibiotics regimen. The series of chest X-rays (Fig. 1) and CT scans (Fig. 2) showed formation of multiple pulmonary cavity-like lesions throughout the course of hospitalization.

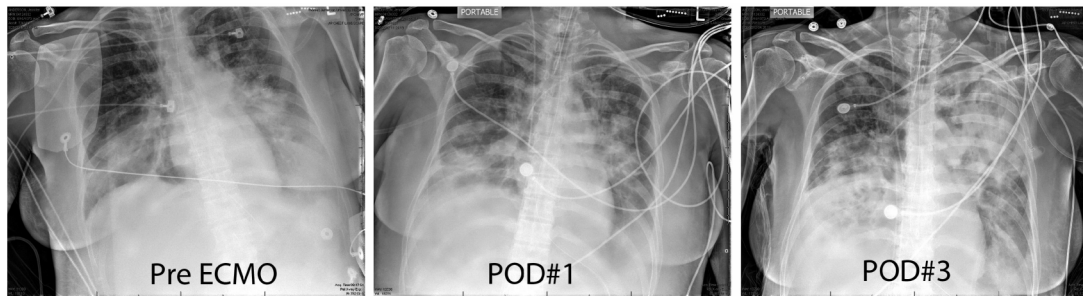


Fig. 1. Serial chest x-rays of the patient. Progression of the infiltrates is observed. POD: post-operative day

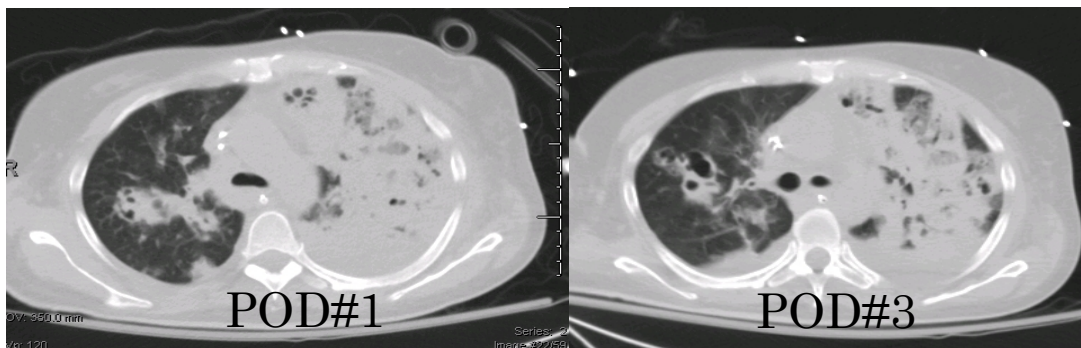


Fig. 2. Serial CT scans of the patient. Progression of the cavity formation is observed. POD: post-operative day

On post-operative day 3, the patient was found to be comatose and near-infra-red spectroscopy (cerebral oximetry) placed bilaterally on the forehead showed a bilateral drop in tissue oxygenation by 20% from baseline (Fig. 3). Emergent CT scan of the head showed multiple embolic strokes including the bilateral temporal and occipital lobe (Fig. 4). The patient expired, and post mortem autopsy showed pancreatic abscesses, multiple lung abscesses (Fig. 5), and septic embolic strokes, consistent with overwhelming MRSA septic emboli, possibly from the pancreatic abscess.

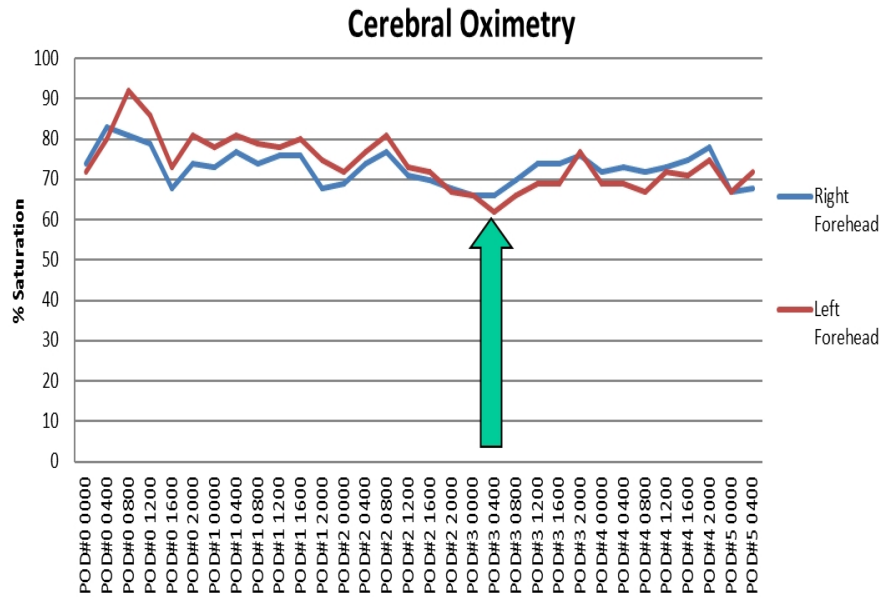


Fig. 3. Trend of cerebral oximetry by near-infra-red spectroscopy. POD: post-operative day



Fig. 4. CT scan of the patient shows multiple strokes

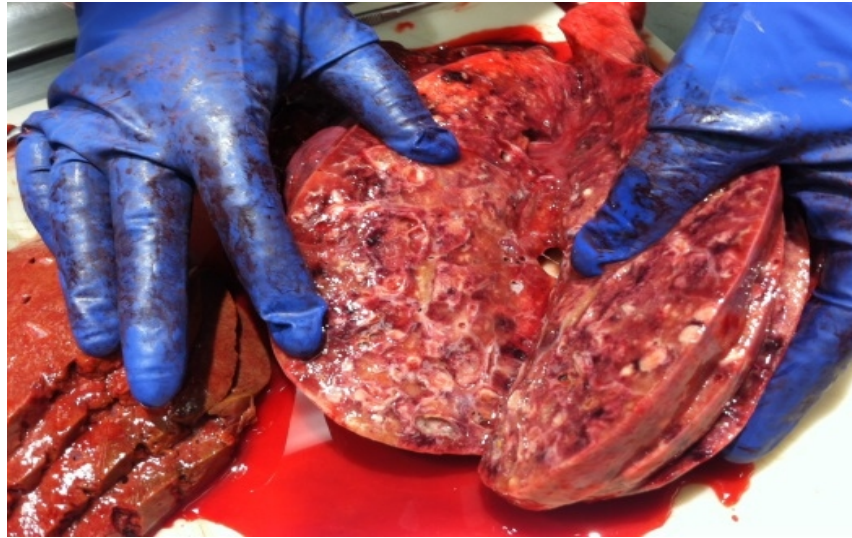


Fig. 5. Autopsy of the lung shows multiple cavitary formation, consistent with MRSA empyema

3. DISCUSSION

It is well documented that adult patients appear to have a significantly increased risk for general infection while being supported with ECMO when compared to pediatric patients [4], though the effect that ECMO has on the mortality and morbidity of an adult patient's clinical course with underlying sepsis has not been investigated. However, there is recent literature regarding the use of VA ECMO and sepsis in pediatric patients, and the survival rates associated with different age groups. Septic neonates placed on VA ECMO (0-1 month, n = 1892 patients) had the highest survival rate at 70%, children (1 month -12 years, n = 169 patients) had a drastically reduced survival rate of 37%, and adolescents (12 - 18 years, n = 25 patients) had an even more reduced survival rate of 29% [5]. This demonstrates an age-related correlation of the utility of ECMO in the survival rate of septic patients on ECMO, which suggests that the older the patient, the higher incidence of ECMO and post-ECMO related mortality amongst those who present with sepsis.

In addition to the poor prognosis of sepsis during ECMO, there also seems to be a worrying trend of the increasing pathogenicity of MRSA that is being presented to clinicians. A review of the ELSO database regarding *Staphylococcus Aureus* in two time frames from 1995-1999 and 2000-2005 noted that there was an >350% increase in MRSA. Mortality of the patients with MRSA also increased to over 50% in the more recent time frame [6]. Not only that, but in the literature involving pediatric cases of MRSA infections requiring ECMO support, there was again a trend with older ages being associated with lower survival rates. Using the International Extracorporeal Life Support Organization database, out of 45 pediatric patients that had underlying MRSA sepsis that was started on ECMO support, it was found that the survival rates of infants (<12 months) was 65%, while youths (5-9 years) had a 0% survival rate [7].

These findings seem to support that idea that while ECMO is a legitimate modality for cardiac support in neonatal patients presenting with underlying sepsis, and even presenting

with MRSA bacteremia, the prognosis of the patient undergoing this procedure is tied to their age. The older the patient is, the worse the prognosis, suggesting that MRSA sepsis may be a contraindication for ECMO in adult patients.

Intermittently, survival of adult patients from septic shock has been reported. Cheng studied patient survival on ECMO and stratified the patients with and without sepsis. He found that there was a 29% survival rate of ECMO for septic patient, which was statistically not inferior to non-infectious patients [8]. We believe their definition of sepsis (newly emerging or uncontrolled infection within 7 days before ECMO initiation) is broader than the standard definition (positive blood culture with fever, increased white blood cell, and hypotension), which is why their outcome of the infectious patients on ECMO was so similar to the non-infectious patients. Moreover, the number of the patients with MRSA infection in their series is unknown.

Brecht [9] reported higher survival rate (71%) of the patients placed on VA ECMO for sepsis related cardiovascular compromise. However, among a total of 222 ECMO patients, we find that only 14 (6.3%) patients had sepsis related refractory shock; thus we suspect there may have been some selection bias in considering patients as ECMO candidates in this study.

Huang reported on the largest series of outcomes of adult patients with septic shock who required ECMO for cardiorespiratory support [10]. All of the patients had positive blood cultures and severe hemodynamic instabilities. Among the 52 patients on ECMO, only 8 patients survived, which give an overall survival rate of 15%. They conclude that the outcomes of the adult ECMO patients for septic shock are unsatisfactory even the current era.

Our patient had septic shock and ARDS, initially thought to be secondary to chemical pancreatitis; however, it was later found out to be secondary to MRSA pancreatitis. The blood cultures immediately prior to ECMO initiation were found to be positive for MRSA and they remained persistently positive for MRSA during the entire course. The source of the infection was not clear until autopsy. The diagnosis of septic shock and ARDS due to MRSA should have precluded her from using VA-ECMO as a modality for cardiac support, although another support modality may not have been sufficient to support her cardiorespiratory failure.

4. CONCLUSION

Our patient presented with major ARDS and septic shock. She had deteriorated to an extremely vulnerable state, and was found to have MRSA sepsis. While there has not been a rigorous look into the outcomes of adult patients with underlying MRSA sepsis and on ECMO, the literature suggests an age-dependent mortality rate of patients with MRSA sepsis, with adult age associated with increased mortality suggest that MRSA sepsis is an absolute contraindication for ECMO placement in adult patients with MRSA sepsis.

CONSENT

Internal review board approved the publication of this case report and accompanying images.

ETHICAL APPROVAL

Authors have obtained all necessary ethical approval from Internal Review Board. This confirms either that this study is not against the public interest, or that the release of information is allowed by legislation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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