DOI: 10.1111/jocs.14583

ORIGINAL ARTICLE

JOURNAL OF CARDIAC SURGERY WILEY

The role of extracorporeal life support for patients with COVID-19: Preliminary results from a statewide experience

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Abstract

Objective: There is a paucity of clinical data on critically ill patients with COVID-19 requiring extracorporeal life support.

Methods: A statewide multi-institutional collaborative for COVID-19 patients was utilized to obtain clinical data on the first 10 critically ill COVID-19 patients who required extracorporeal membrane oxygenation (ECMO).

Results: Of the first 10 patients that required ECMO for COVID-19, the age ranged from 31 to 62 years with the majority (70%) being men. Seven (70%) had co-morbidities. The majority (80%) of patients had known sick contact and exposure to COVID-19 positive patients or traveled to pandemic areas inside the United States within the 2 weeks before symptom onset. None of the patients were healthcare workers. The most common symptoms leading to the presentation were high fever ≥103°F (90%), cough (80%) and dyspnea (70%), followed by fatigue and gastro-intestinal symptoms (both 30%), myalgia, loss of taste, pleuritic chest pain, and confusion (all 10%). All patients had bilateral infiltrates on chest X-rays suggestive of interstitial viral pneumonia. All patients were cannulated in the venovenous configuration. Two (20%) patients were successfully liberated from ECMO support after 7 and 10 days, respectively, and one (10%) patient is currently on a weaning course. One patient (10%) died after 9 days on ECMO from multiorgan dysfunction.

Conclusions: These preliminary multi-institutional data from a statewide collaborative offer insight into the clinical characteristics of the first 10 patients requiring ECMO for COVID-19 and their initial clinical course. Greater morbidity and mortality is likely to be seen in these critically ill patients with longer follow-up.

KEYWORDS

cardiogenic shock, coronavirus, COVID-19, ECMO

Ibrahim Sultan and Andreas Habertheuer contributed equally to this study.

1 | INTRODUCTION

COVID-19 is a novel coronavirus disease and Word Health Organization (WHO) declared pandemic caused by severe acute respiratory syndrome coronavirus (SARS CoV-2) which belongs to the same family of bat-borne betacoronaviruses responsible for the SARS endemic in 2002 and 2003. Since initial reports emerged from Wuhan, China in late 2019, the virus has spread around the globe with unprecedented speed, stressing healthcare systems, overburdening intensive care units (ICUs) and challenging allocation of resources and medical supplies. As of early April 2020, the virus has infected at least 1 263 976 patients worldwide and claimed 69 082 lives.[1] Most infections are reported in the United States with 331 234 confirmed cases and 9458 (2.9%) mortalities. With the first larger reports emerging and most patients exhibiting only mild and uncomplicated illness, about 14% require hospitalization and 5% require ICU level care for acute respiratory distress syndrome (ARDS).[2] The WHO interim guidelines[3] recommends expanding therapeutic armamentarium in this setting to venovenous extracorporeal membrane oxygenation (ECMO) at expert centers. Although observational data exist on the use of ECMO in the context of infectious diseases during prior outbreaks such as SARS, Middle East respiratory syndrome (MERS) and influenza A (H1N1) the overall impact on survival remains unclear.[4] To date, there is a paucity of data describing characteristics of COVID-19 positive patients with therapy refractory respiratory failure eligible for ECMO in the United States. The aim of our multicenter case series was to describe baseline characteristics, coexisting comorbid conditions, resource utilization as well as provisional outcomes among critically ill patients with COVID-19 associated ARDS in the state of Pennsylvania.

2 | METHODS

The first 10 patients who were placed on ECMO for COVID-19 in the state of Pennsylvania were included in the study. Patients from five hospitals with laboratory-confirmed COVID-19 infection were included in the study and analyzed with descriptive statistics. This was done via a multi-institutional statewide collaborative. Baseline characteristics of patients who were confirmed COVID-19 via laboratory testing were included. Their laboratory and clinical findings including their clinical course, time to ECMO and recovery were obtained.

3 | RESULTS

By the first week of April 2020, 10 patients in the state of Pennsylvania required ECMO support for ARDS secondary to COVID-19 infection to our knowledge. Of those, age ranged from 31 to 62 years, 70% were men, 40% Caucasian. Median body mass index (BMI) was 33 kg/m^2 (interquartile range [IQR], 28-38). Seven (70%) patients had comorbid conditions including hypertension, diabetes, hyperlipidemia, asthma, obstructive sleep apnea, systemic lupus erythematosus, and glucose-6-phosphate-dehydrogenase deficiency. One (10%) patient had a history of recurrent pulmonary embolisms and adrenal insufficiency. Home medications included losartan, albuterol, metformin, and rivaroxaban. Only two (20%) patients reported a history of smoking and one (10%) patient had a history of alcohol abuse, one (10%) admitted to drug use. There were no prior cardiovascular procedures noted. The majority (80%) of patients had known sick contact and exposure to COVID-19 positive patients or traveled to pandemic areas inside the United States within the 2 weeks before symptom onset. None of the patients were healthcare workers.

The most common symptoms leading to the first presentation were high fever ≥103°F (90%), cough (80%) and dyspnea (70%), followed by fatigue and gastrointestinal symptoms (both 30%), myalgia, loss of taste, pleuritic chest pain, and confusion (all 10%). All patients had bilateral infiltrates on chest X-rays suggestive of interstitial viral pneumonia. On hospital admission, two patients had elevated ferritin and interleukin-6 (IL-6) levels suggestive of the cytokine storm. Two (20%) patients were admitted via the emergency department (ED), developed ventilation refractory and EMCO dependent respiratory failure during hospitalization; three (30%) patients were escalated in the ED through various levels of respiratory support to emergent cannulation for ECMO for refractory hypoxemia, and five (50%) patients were intubated in an outside hospital and transferred for higher-level care. Of note, one patient suffered a PEA arrest 2 days before cannulation for ECMO and required vasopressors and bicarbonate and one patient required continuous renal replacement therapy (CRRT) 1 day before cannulation. All patients were cannulated in venovenous configuration, 20% had bifemoral cannulas and 80% had bicaval cannulas via internal jugular and femoral access sites. Initial ECMO flows were 3.5 to 5.8 L/min, six (60%) patients required initial vasopressors for hemodynamic stabilization on ECMO. Median time from symptom onset to hospitalization was 4 days (IQR, 3-9), the median time from the first symptom to intubation was 8 days (IQR, 4-9), and the median time from the first symptom to cannulation for ECMO was 11 days (IQR, 7-14). In the hospital, medications included hydroxychloroquine (100%), remdesivir (40%), steroids (40%), and antibiotics (70%). Of note, three (30%) patients received IL-6 inhibitors for suspected cytokine storm. Two (20%) patients required CRRT due to acute kidney injury while on ECMO. Two (20%) patients were successfully liberated from ECMO support after 7 and 10 days, respectively, and one (10%) patient is currently on a weaning course. There was one death after 9 days on ECMO due to multiorgan dysfunction. All other patients remain on ECMO with a median time of support of 11 days (IQR, 4-14) as of 9th April (Figure 1).

4 | DISCUSSION

This multicenter case series describes the clinical course of the first 10 critically ill patients with confirmed COVID-19 infection who developed acute hypoxic respiratory failure secondary to ARDS requiring emergent salvage ECMO. We included all known patients in

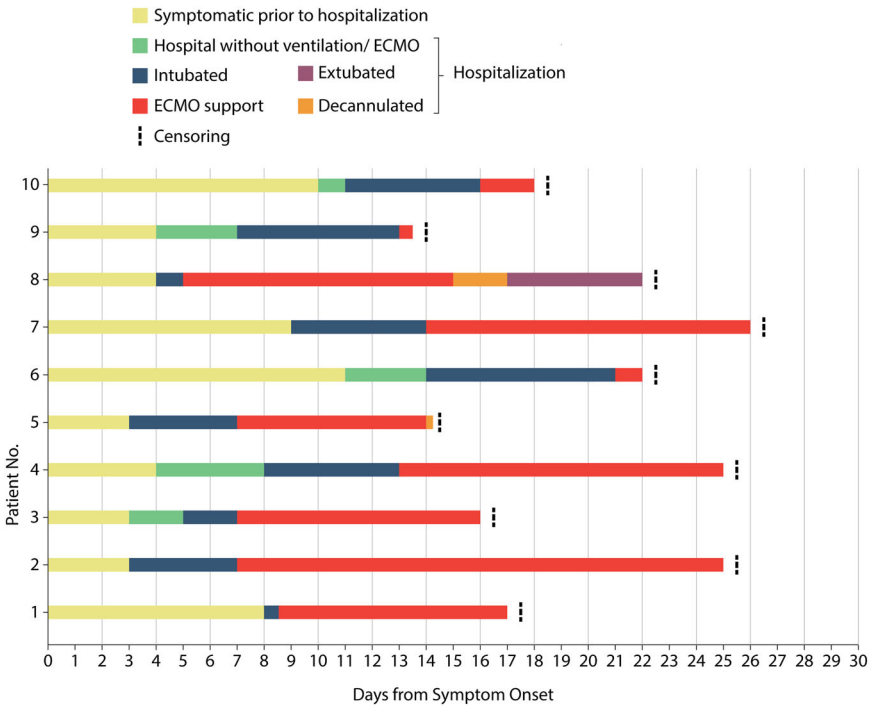

FIGURE 1 Individual course of COVID-19 patients with ARDS requiring salvage ECMO. ARDS, acute respiratory distress syndrome; ECMO, extracorporeal membrane oxygenation

the state of Pennsylvania on ECMO as of the first week of April. Even though preliminary in nature, our results offer hope. All patients in our series presented with respiratory symptoms (dyspnea and cough). Similar to reports from China,[2] critically ill patients progressing to ARDS showed male predominance and the majority had preexisting comorbid conditions, including obesity (median BMI, 33). All patients in this series were characterized by an accelerated progression of symptoms and homogenous pictures of respiratory decline. From the onset of symptoms, the median time to hospital admission, intubation and ECMO was 4, 8, and 11 days, respectively. All patients were on venovenous support, the majority had bicaval configuration. Of note, 40% of patients received the Ebola antiviral remdesivir and 100% received hydroxychloroquine, a substance effective in the treatment of malaria with immunosuppressive and antiviral properties. In addition, 30% of patients received IL-6 inhibitors for cytokine storm. With this maximal effort, one mortality occurred, two patients were successfully weaned from ECMO and one patient is on a weaning course.

Ventilator management was variable at different institutions with the primary goal of using lung-protective strategy while oxygenating and ventilating adequately. Prone positioning was utilized aggressively before the institution of ECMO unless rapid deterioration occurred at which point ECMO was initiated.[5] Providing complex therapies such as rescue ECMO during outbreaks of infectious diseases has unique challenges.[4] ECMO is resource-intensive, a scarce resource in times of high demand[4] highly specialized and expensive with the potential for serious complications such as hemorrhage, thrombosis, and propagation of infection.[6] Apart from infectious disease outbreaks, ECMO is an evidence-based service,[4] but data are scarce in the context of infectious diseases and were uniformly derived during prior outbreaks of such influenza A (H1N1) and MERS with mortality rates between 21% and 65%.[7,8] Since then, ECMO availability has increased dramatically. According to the Extracorporeal Life Support Organization, there were a total of approximately 1900 ECMO runs worldwide in 117 centers in the years 2002 and 2003 (SARS), 3262 runs in 164 in 2009 (H1N1), and 12 850 runs in 2019 in 430 centers.[9]

Because of the rapidly evolving nature of the disease, no comprehensive report exists in the context of COVID-19. Such data, when reported, would be critical to guide critical care management and the allocation of ICU resources and ECMO infrastructure. As the world is bracing for the COVID-19 outbreak preparation should include the provision of ECMO and our report is an attempt at characterizing this novel patient population to aid in the establishment of selection criteria.

Our report has multiple limitations. First, this is a case series in one state that may not represent what is seen in most of North America. Second, since the COVID-19 pandemic has clustered in certain areas when compared to others, ECMO may not be utilized as liberally in highly affected areas with limited resources and personnel.[10] Third, these data present an initial experience and do not reflect the complete clinical course of most of these patients.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

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How to cite this article: Sultan I, Habertheuer A, Usman AA, et al. The role of extracorporeal life support for patients with COVID-19: Preliminary results from a statewide experience. *J Card Surg*. 2020;35:1410–1413.
https://doi.org/10.1111/jocs.14583