Case Series

Extracorporeal Membrane Oxygenation for COVID-19 Treatment in a Community Hospital

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Abstract

Description

Coronavirus disease 2019 (COVID-19) may result in severe acute respiratory disease syndrome (ARDS) and death. For COVID-19 patients failing mechanical ventilation, extra corporeal membrane oxygenation (ECMO) has been used with varying efficacy in academic medical centers and quaternary referral centers. We report the successful use of veno-venous (VV) ECMO to treat refractory ARDS due to COVID-19 in a community hospital setting with a survival to discharge rate of 71% over a 3 month period. In a community hospital with adequate resources, VV ECMO can be an effective rescue therapy for selected COVID-19 patients who fail all other available treatments.

Keywords

coronavirus infections/complications; coronavirus infections/therapy; COVID-19; SARS-CoV-2; pandemics; viral pneumonia; extracorporeal membrane oxygenation; acute respiratory distress syndrome/therapy

Introduction

To date, the hospital mortality rate for patients with coronavirus disease 2019 (COVID-19) infection requiring mechanical ventilation has been shown to be greater than 30%.[1] The most frequent cause of death is progressive acute respiratory disease syndrome (ARDS), which has failed to respond to available drug treatments or measures to optimize mechanical ventilation, including paralysis, proning and novel modes of ventilation. Extra corporeal membrane oxygenation (ECMO) has been used as a rescue therapy for these patients in academic and quaternary care centers. Physiologic advantages of ECMO includes the treatment of right ventricular dysfunction. Even with the enhanced availability of resources at these referral centers, reports of ECMO treatment outcomes for COVID-19 patients demonstrate mortality rates of greater than 50%, leading some researchers to be against recommending this treatment.[2] Our case series evaluates the clinical outcomes from a community hospital of a cohort of COVID-19 patients who received veno-venous (VV) ECMO treatment for refractory ARDS.

Material and Methods

Permission to review electronic medical records retrospectively of all COVID-19 patients admitted to our intensive care unit (ICU) for the study period was obtained from our institutional review committee. Between March 1st and May 31st, 2020, all consecutive COVID-19 patients admitted to the ICU at the Regional Medical Center of San Jose were evaluated and included in our electronic database. The Regional Medical Center of San Jose is a 258-bed community hospital with an average daily census of 170 patients.

The ECMO program is comprised of 2 cardiothoracic surgeons, 14 medical intensivists, 4 perfusionists and 18 ECMO-trained ICU nurses. There is also a 1:1 patient-nurse ratio, which augments care to the COVID-19 patients receiving ECMO. The intensivists and perfusionists remained in-hospital at all times. The decision to initiate VV ECMO was based on a consensus between the thoracic surgeon, attending intensivist and ICU medical director along with consent from the patient's family. Criteria for initiation of VV ECMO included

clinical evidence of progressive ARDS and failure of efforts at optimal mechanical ventilation, including proning as well as a ratio of Pao_2/Fio_2 (P:F) less than 80 for greater than 6 hours, with Fio_2 greater than 80% and positive end expiratory pressure (PEEP) greater than 10 mm Hg. Patients who were going to receive VV ECMO were cannulated at their bedsides with ultrasound guidance and anesthesiology support. During cannulation and at all other times during the ICU course for COVID-19 patients receiving mechanical ventilation or ECMO, all bedside personnel wore enhanced personal protective equipment (PPE) including positive airway pressure respirators (PAPR). The procedure rooms were either negative pressure rooms or standard enclosed normal pressure ICU rooms with a portable high efficiency particulate air (HEPA) filter. The patients were sedated and paralyzed pre-procedure. A right internal jugular approach was used to place a 28-French Crescent (MC3 Cardiopulmonary, Dexter, MI) dual lumen ECMO catheter with distal tip positioned in the inferior vena cava (IVC). A CentrimagTM (Abbott Laboratories, Abbott Park, IL) circulatory support system was used. All patients received continuous intravenous (IV) heparin adjusted to a partial thromboplastin time (aPTT) of 1.5 to 2 times control value. Pre- and post-membrane oxygenation was monitored daily. Lung protective ventilation strategy was followed per best practice guidance protocols.[3] An infectious disease consultant guided any indicated anti-bacterial or anti-viral treatment. VV ECMO was discontinued and patients were decannulated at their bedsides once ventilator support settings were acceptable per published guidelines.[4]

Results

During the 3 month study period, 70 patients with COVID-19 were admitted to the ICU at Regional Medical Center of San Jose. From this cohort, 57 (81%) developed acute respiratory failure requiring mechanical ventilation. Seven (12%) of the mechanically ventilated patients developed progressive ARDS and met criteria for initiation of ECMO as described in the methods section. All patients receiving VV ECMO were younger than 70 years of age with a median age of 57 years. Four of the 7 patients were women and 3 were men. The ethnicities of the patients were either Hispanic or Southeast Asian. The median body mass index (BMI) was 36 kg/m^2 and 2 of the 7 patients met the criteria for morbid obesity with a BMI greater than 40 kg/m^2. Six of the 7 patients were diabetic. Other co-morbidities included 4 patients with hypertension and 1 with non-ischemic cardiomyopathy. Three of the 7 patients had developed bacterial pneumonia, 2 with Klebsiella and 1 with Serratia. Pneumonias were treated with appropriate antibiotics. Two of the 7 patients received remdesevir, tocilizumab and steroids.

The median duration of VV ECMO was 11 days with a minimum of 6 days and a maximum of 37 days. The median duration of mechanical ventilation pre-ECMO was 5 days and 8 days post-ECMO. Three of the 7 patients received tracheostomy post-ECMO. The median duration of hospitalization was 40 days. Five of the 7 (71%) VV ECMO patients survived to discharge. Two of the 7 patients were discharged home, 2 to long-term ambulatory care (LTAC) facilities and 1 transferred to another hospital due to a third party payer request. Two patients died, 1 during ECMO cannulation with perforation of the right ventricle. Another patient died after 6 days of VV ECMO following cardiopulmonary arrest that resulted in severe cerebral anoxia. For the mechanically ventilated patients in our ICU who did not receive VV ECMO, 34 of 50 patients (68%) survived to discharge.

Discussion

Discovery of more effective treatments and a vaccine against COVID-19 infection is being aggressively pursued. Currently, 3–5% of patients infected with COVID-19 become critically ill.[1] In our hospital, the majority of those admitted to the ICU developed progressive ARDS and required mechanical ventilation. The mortality rate for mechanically ventilated COVID-19 patients, excluding those who received VV ECMO at our hospital, was 32%, which was similar to that recently described from a larger cohort.[1]

The mounting death toll for patients who fail mechanical ventilation from ARDS due to COVID-19 makes efforts to salvage their lives imperative. Our case-series demonstrates that this life-saving therapy may be available

to COVID-19 patients at non-academic and smaller hospitals with ECMO programs. As was demonstrated with the H1N1 epidemic,[5] it is possible to transport ARDS patients to academic and quaternary care centers for VV ECMO, though the feasibility of transfer during the current pandemic may be less likely due to the scarcity of resources during surge periods. The availability of on-site ECMO cannulation and transport teams may also be markedly limited.

Even with the enhanced availability of resources at these referral centers, reports of ECMO treatment outcomes for COVID-19 patients demonstrate mortality rates of greater than 50%, leading some researchers to recommend against this treatment.[2] While the number of ECMO patients in this case-series is small, we believe that a well-organized ECMO program in a community hospital with appropriate resources and careful patient selection can achieve results similar to those of larger academic centers.[6] Our results exceed those of 2 recently published studies from China of COVID-19 cohorts comprised of 8 patients[7] and 21 patients[8] treated with VV ECMO, which demonstrated survival rates of 50% and 56% respectively. Additionally, the Extracorporeal Life Support Organization (ELSO) registry of COVID-19 patients, receiving predominantly VV ECMO, indicates a 56% rate of survival to discharge. Another recently published case series of 40 COVID patients in an academic medical center demonstrated a survival to discharge of 73%,[9] which is similar to the survival rate of our case series. Compared to the higher mortality rates of other studies of VV ECMO in diseases other than COVID, it is possible that increased survival could be a result of these COVID patients having few co-morbidities other than obesity, diabetes mellitus or hypertension.

Conclusion

Our case series suggests that the availability and efficacy of VV ECMO as a rescue therapy for patients with progressive ARDS can be enhanced by the development of ECMO capability at smaller, non-academic hospitals with appropriate resources, staff training and careful patient selection.

Abbreviations

Coronavirus disease 2019 (COVID-19), acute respiratory disease syndrome (ARDS), extra corporeal membrane oxygenation (ECMO), intensive care unit (ICU), positive end expiratory pressure (PEEP) , personal protective equipment (PPE), positive airway pressure respirators (PAPR), high efficiency particulate air (HEPA), long-term ambulatory care (LTAC), Extracorporeal Life Support Organization (ELSO)

Conflicts of Interest

The authors declare they have no conflicts of interest.

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