

Extracorporeal membrane oxygenation to treat a 15-year-old patient with severe coronavirus disease 2019 (COVID-19) respiratory failure



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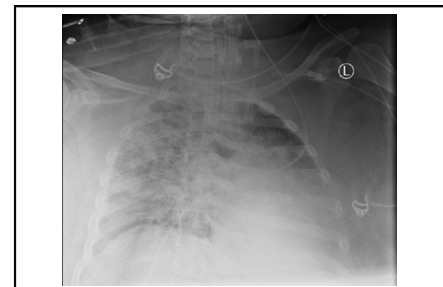
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Severe acute respiratory distress syndrome (ARDS) secondary to a novel coronavirus, coronavirus disease 2019 (COVID-19; severe acute respiratory syndrome coronavirus 2 [SARS-CoV-2]), was first reported in Wuhan, China, in December 2019, and quickly spread to become a global pandemic. Children are less commonly affected but those with complex medical histories may be susceptible to severe forms of disease, with a mortality rate of almost 5%.¹ We present the case of a pediatric patient with multiple comorbidities who presented with SARS-CoV-2 and was successfully treated with venovenous extracorporeal membrane oxygenation (VV-ECMO).

CLINICAL SUMMARY

A 15-year-old female patient with a history of morbid obesity (body mass index of 56), hypertension, hypothyroidism, prediabetes, and asthma presented to an affiliated institution with cough, shortness of breath, and fatigue. On presentation to the emergency department, her oxygen saturation was 55% on room air and increased to 88% on 15 L/min non-rebreather. Due to her severe hypoxic respiratory failure, she was admitted to the pediatric intensive care unit, intubated, and placed on mechanical ventilation. Her requirements escalated, necessitating transfer to our institution for higher level of care. On arrival, she had an arterial oxygen tension/inspired oxygen fraction ratio of 55, consistent with a diagnosis of severe ARDS. Her confirmatory nasopharyngeal polymerase chain reaction test was positive for COVID-19, and chest radiograph revealed pathognomonic bilateral pulmonary parenchymal opacities



Bilateral pulmonary parenchymal opacities pathognomonic of COVID-19 respiratory failure.

CENTRAL MESSAGE

The presentation of COVID-19 may be life-threatening in children with multiple comorbidities. Multimodality therapy including VV-ECMO and plasma exchange may play an important role in management.

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(Figure 1). She was initiated on intravenous antibiotics, dexamethasone, enoxaparin anticoagulation, inhaled nitric oxide (40 ppm), and placed in a prone position. Convalescent plasma therapy and intravenous remdesivir (Gilead Sciences Inc, Oceanside, Calif) were also administered. She developed acute oliguric renal injury and diastolic hypotension requiring low-dose norepinephrine infusion. Remdesivir was discontinued, given the deterioration in renal function. The ECMO team was consulted for persistent arterial oxygen tension/inspired oxygen fraction ratio <80 for several hours. Following multidisciplinary evaluation, she was deemed a candidate for VV-ECMO as a bridge to recovery.

She was cannulated using a 20-F Fem-Flex (Edwards Lifesciences, Irvine, Calif) return cannula in right internal jugular and a 25-F Multistage (Medtronic, Minneapolis, Minn) right femoral venous drainage cannula. Intravenous bivalirudin was used for anticoagulation as per institutional



FIGURE 1. Chest radiograph on admission depicting bilateral dense pulmonary parenchymal infiltrates that are pathognomonic of severe acute respiratory syndrome secondary to coronavirus disease 2019.

protocol. On ECMO day 1, she was weaned off vasopressors and sweep flow titrated down from 5 L to 3.5 L. She was extubated on ECMO day 2 and over the next 3 days received diuretics and convalescent plasma (4 doses). She underwent therapeutic plasma exchange (TPE) on ECMO day 5 to mitigate the cytokine storm. Bronchioalveolar lavage and blood cultures obtained were negative. On ECMO day 9, she underwent a second session of TPE, which normalized her inflammatory markers (Table 1). On ECMO day 10, she was weaned off gases and successfully decannulated requiring oxygen at 4 L/min nasal cannula with oxygen saturation >95%. She transferred out of the pediatric intensive care unit 2 days post ECMO decannulation. Thereafter, she continued to recover and was discharged home 7 days later after a total hospitalization of 19 days. Informed consent was obtained from the patient’s mother for the publication of case data.

DISCUSSION

Children have been less afflicted by COVID-19 disease and may even remain asymptomatic in most cases. Indeed, only 8 per 100,000 population require hospital admission.² However, pre-existing comorbidities and concomitant infection of lower respiratory tract increase the risk of intensive care unit admission 3- and 10-fold, respectively.³ Approximately 3900 patients with SARS-CoV-2 have been managed with ECMO per Extracorporeal Life Support Organization reports. There is, however, a paucity of reports pertaining to the pediatric population. In a European survey,

TABLE 1. Inflammatory markers pre- and post-TPE

Inflammatory marker	Pre-TPE	Post-TPE
C-reactive protein, mg/L	117	22
D-dimer, ng/mL	1354	666
Fibrinogen, mg/dL	481	239

TPE, Therapeutic plasma exchange.

only 7 children in 52 centers required ECMO during the 3.5 months that constituted the “first surge.”⁴ The majority required venoarterial ECMO. The median time between intubation and initiation of ECMO was 36 hours, and the duration of ECMO ranged between 7 and 11 days. All 7, however, required mechanical ventilation for the duration of support. Our patient, in contradistinction, was extubated and ambulatory after 2 days, in keeping with our programmatic motto, “cannulate, extubate, ambulate.”

COVID-19 infection in the pediatric population varies in presentation and may manifest itself as multisystem inflammatory syndrome in children, characterized by a hyperimmune response and elevated cytokines. ARDS is accompanied by, unrelenting multisystem organ failure and coagulation dysfunction. In these patients, TPE may be a viable a treatment option.⁵ Indeed, this therapy may also be extrapolatable in the treatment of septic shock and/or multiorgan failure.⁵ Our patient met our programmatic criteria for plasma exchange by both acuity of condition and the scale of inflammatory perturbation. It is likely to have been of tremendous therapeutic benefit that changed the trajectory of her life-threatening course. This case highlights the novel use of a multidisciplinary approach and multimodality therapy, including VV-ECMO and TPE, in the successful treatment of a pediatric patient with SARS-CoV-2.

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