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Case Review

Extracorporeal Membrane Oxygenation in a 39-Year-Old Man with Traumatic Pulmonary Contusions and Acute Respiratory Distress Syndrome

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The patient was a 39-year-old man with a history of epilepsy who was involved in a high-speed rollover single-vehicle motor accident. Apparently, he was traveling approximately 70 mph, and his vehicle crashed. The exact mechanism was unknown. He was entrapped for a prolonged duration while his vehicle was engulfed in flames. After extrication, he was ambulatory with 33% total body surface area full-thickness burns. Additionally, he had partial-thickness burn injuries to his face, torso, and upper extremities. He was transported via rotor wing emergency medical services to an outside level I trauma center for evaluation. During transport, he was intubated because of concern for inhalational injury and airway protection without complication. The patient underwent computed tomographic (CT) imaging of his head, chest, abdomen, and pelvis; it showed additional bilateral pulmonary contusions as well as a traumatic subarachnoid hemorrhage (SAH). He was transferred to the burn intensive care unit for continued care.

While in the burn unit, his respiratory status deteriorated within 48 hours after injury with the inability to oxygenate. He developed severe acute respiratory distress syndrome (ARDS) with significant pulmonary contusions that were refractory to prone positioning and continuous neuromuscular blockade. Despite these interventions, his hypoxia worsened. On day 3 after injury, in the setting of severe refractory ARDS on conventional therapies for this condition, a critical care team from an outside level I trauma facility with additional cardiovascular capabilities was called for possible venovenous (VV) extracorporeal membrane oxygenation (ECMO). The ECMO team was transported via aircraft to the outside hospital.

At the outside hospital, the ECMO team cannulated and began VV ECMO, and the patient was transferred for a higher level of care. A chest x-ray after cannulation showed bilateral pulmonary edema (Fig. 1). A CT scan of the chest performed 24 hours after the initiation of ECMO (four days after injury) also showed continued diffuse pulmonary edema (Fig. 2). Collaborating services included critical care, neurosurgery, trauma surgery, burn surgery, ophthalmology, neurology, interventional radiology, cardiology, and nephrology staff.

A definitive tracheostomy tube was placed nine days after injury. Ultimately, the patient's respiratory status improved while on ECMO and he was subsequently decannulated from the ECMO unit successfully after 10 days of therapy (Fig. 3). He required multiple debridements with excision and soft tissue skin grafting placement to the noted burn injuries. His wounds continued to heal, and eventually tracheostomy was decannulated, which was tolerated well after 32 days. On discussion with neurosurgery, the SAH initially observed on the outside hospital CT scan was a known cavernoma with a possible old surrounding hemorrhage, which was likely why he had a seizure disorder. He was discharged to an inpatient rehabilitation facility for continued physical and occupational therapy. He has made a full recovery and is currently living independently with no significant deficits except left eye lagophthalmos (the inability to close his eyelid completely). The etiology of this deficit was undetermined.

ECMO Discussion

ECMO, also known as extracorporeal life support (ECLS) or extracorporeal cardiopulmonary resuscitation (ECPR), is a form of mechanical cardiopulmonary support used in cases of severe respiratory and/or hemodynamic failure. There are two forms: VV and venoarterial (VA). VV ECMO is used in respiratory failure and requires cannulation of two large veins. VA ECMO provides both respiratory as well as hemodynamic support and requires cannulation of a vein and an artery (Fig. 4).

ECMO is a temporizing supportive measure. Indications for ECMO must be reversible disease processes including cardiac and/or pulmonary failure that is unresponsive to conventional therapy. The Extracorporeal Life Support Organization establishes guidelines and incorporates mortality into the consideration for ECMO; it defines indications as follows[1]:

> Acute severe heart or lung failure with high mortality risk despite optimal conventional therapy. ECLS is considered at 50% mortality risk, ECLS is indicated in most circumstances at 80% mortality risk. Severity of illness and mortality risk is measured as precisely as possible using measurements for the appropriate age group and organ failure.

Some examples of cases in which ECMO has been found beneficial include respiratory failure, ARDS, cardiogenic shock, cardiac

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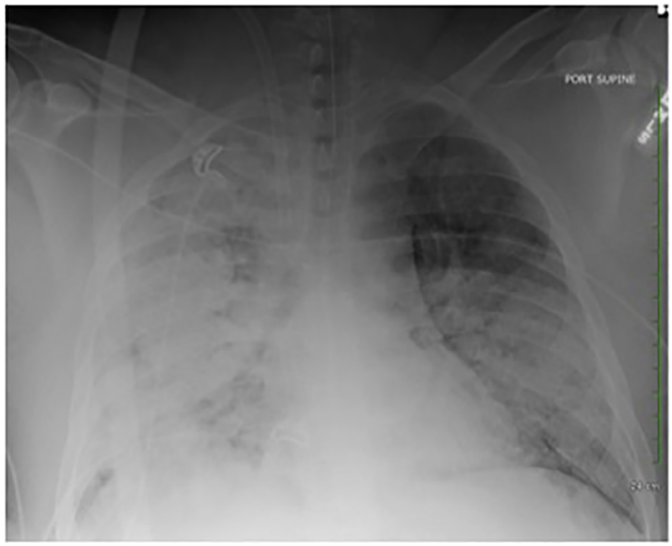

Figure 1. A portable chest x-ray status post VV-ECMO cannulation. Note the bilateral airspace disease consistent with pulmonary edema and/or multifocal pneumonia.

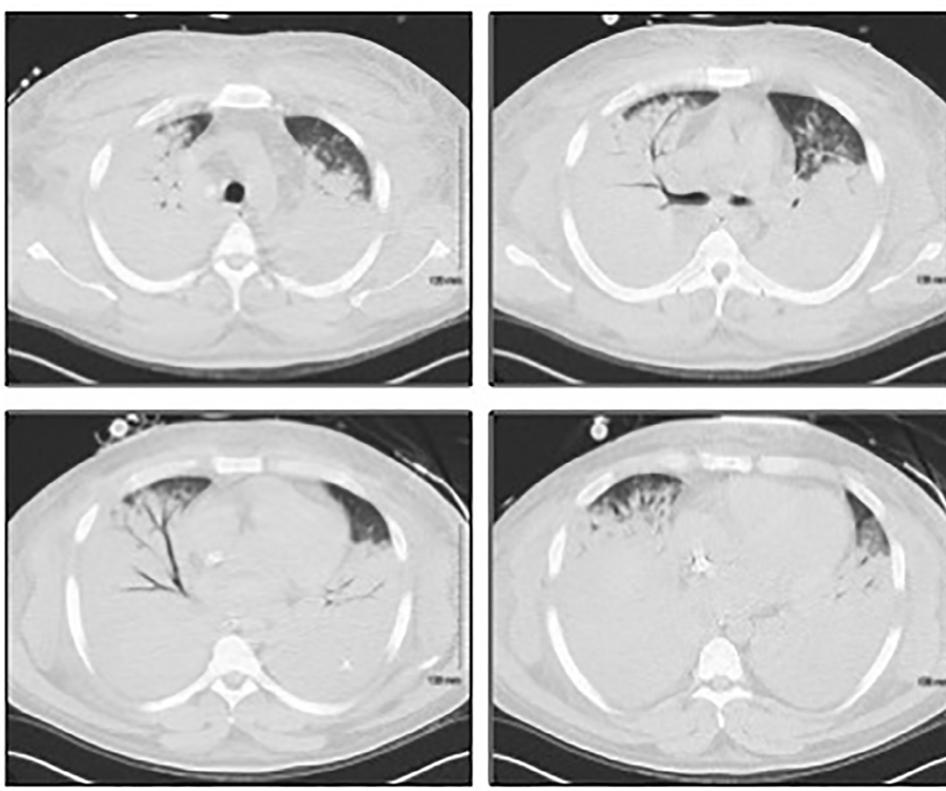

Figure 2. A CT scan of the chest performed 24 hours after ECMO cannulation demonstrating diffuse pulmonary edema.

arrest, massive pulmonary embolism, or a bridge for lung or heart transplant. The only absolute contraindication to ECMO is a preexisting condition incompatible with recovery, thus the importance of a reversible disease process. Additional contraindications are relative and include considerations regarding baseline neurologic status, risk of bleeding, prognosis, and futility.

Once it is determined to place a patient on ECMO, many resources are mobilized. This can take place in any setting with proper resources including the operating room, emergency department, intensive care unit, cardiac catheterization laboratory, bedside, or even in the prehospital setting for patients meeting strict criteria. A patient in refractory cardiac arrest was placed on ECPR in Paris's Louvre Art Museum, successfully showing the capability to implement ECMO in the field.[2] As technology advances, the ECMO unit is becoming smaller and more portable; thus, the ability to initiate it depends highly on the available resources and not as much on location.

Utility of ECMO

There have been several studies published analyzing the use of ECMO in several