Extracorporeal membrane oxygenation

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It is a pleasure to join the editors of this edition of the *Indian Journal of Thoracic and Cardiovascular Surgery* focused on extracorporeal life support, otherwise known as extra corporeal membrane oxygenation (ECMO). ECMO began in the 1960s in a few laboratories which developed the devices and the technology, and demonstrated that prolonged support without native heart or lung function was possible. The first clinical cases were in the 1970s. ECMO was very successful in newborn infants and children, but not in adult cases. For the next two decades, most of ECMO were in pediatrics and neonatal cases. Research continued on ECMO for adult patients in a few focused research centers. By the year 2000, ECMO was being used for adult cases in a few places around the world. By 2010, new ECMO devices were available which were simpler and safer than the previous devices. This led to a worldwide growth of ECMO for adult patients with severe cardiac and pulmonary failure. ECMO is now an important step in the algorithm for managing cardiac and respiratory failure in adults worldwide.

In India, the first ECMO cases were in the early 2000s, mostly for support of cardiac failure in adults. In 2008, the ECMO center in Mumbai, directed by Dr. Venkat Goyal, was well established. The results demonstrated that ECMO could be very valuable in the Indian subcontinent. The ECMO Society of India was instituted in 2010 and in 2013 the Southwest Asia Chapter of Extracorporeal Life Support Organisation (ELSO) was established. This issue of the *Indian Journal of Thoracic and Cardiovascular Surgery* has excellent examples of the current status of ECMO technology in India.

Currently, ECMO is the next step in the management of severe cardiac and respiratory failure patients, who are failing despite optimal conventional treatment. Current research is focused on identifying the specific physiologic indications for ECMO, the best methods of vascular access, the management of sedation and

intubation in ECMO patients, and most importantly, the physiologic goals of ECMO management.

The indications for using ECMO can be simply defined as profound circulatory failure and shock, or profound respiratory failure identified by severe hypoxemia and hypercarbia, despite optimal conventional therapy. The physiologic indications of “unresponsive to conventional therapy” too are easy to define. The biggest problem is to decide when to use ECMO for patients who meet these indications. Like any other organ replacement technology, the time to use the technology is as soon as the patient meets these indications, not after more hours or days of trying to improve the situation. The major contraindication is no likelihood of returning to normal health after ECMO (severe brain injury for example). The use of ECMO for elderly patients is possible, but should be based on physiologic data and comorbidity, rather than chronologic age per se.

Patients with combined respiratory and cardiac failure are very well supported with veno-arterial (VA) access. In adults, V-A access is usually done by cannulation of the inferior vena cava (IVC) and right atrium through a femoral vein, and arterial access via a femoral artery. In V-A access, it is important to establish perfusion of the leg at the time of cannulation (not a few hours later). For respiratory failure with good cardiac function, VA access can be used, but veno-venous (VV) access is used more commonly. V-V access avoids the problems of arterial access, including limb perfusion, and systemic micro- and macro-embolism. Veno-venous access is achieved by drainage of venous blood from the inferior vena cava via a femoral vein and reinfusion into the right atrium via the jugular vein. That type of access is easily done at the bedside, or in the operating room, and does not require imaging while access cannulae are placed. Alternative methods of VV access are drainage via one femoral vein and reinfusion into the right atrium via another femoral vein. Another method of access is to use a double lumen cannula placed via the jugular vein into the venous circulation. Drainage is from the IVC and superior vena cava (SVC) with reinfusion directly into the right atrium. This method of access requires imaging by ultrasound or radiography to assure correct placement of the catheter. In all types of access, the amount of flow that can be obtained is

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based on the resistance in the venous drainage cannula. Therefore, the largest possible cannula should be placed for venous drainage.

These patients are intubated and very heavily sedated when ECMO is instituted. As soon as stable ECMO is established, the patient should be awakened completely to establish the neurologic status. Then, minimal sedation is continued throughout the course of ECMO. Many centers are routinely extubating both V-A and V-V patients because pulmonary support is totally provided by the circuit and the risks of intubation or tracheostomy are eliminated by extubation.

Physiologic management of the patient during ECMO can be simply summarized: *the goal is to maintain normal systemic blood pressure, normal PaCO₂, and to maintain oxygen delivery at least 3 times oxygen consumption.* The latter goal in V-V access can be summarized as “adjust the blood flow and the hemoglobin level to keep the arterial saturation at least 80% with a goal of 90%.” Meeting these physiologic goals requires a thorough understanding of normal cardiopulmonary physiology, and how that physiology is replaced by the ECMO circuit.

The major limitation to the use of ECMO, with good results, is education of the physicians in the intensive care community. It takes education and experience to understand the physiology of extracorporeal life support and how to use it to manage these patients. The idea that it is desirable to extubate patients with no lung function, and to manage patients with an arterial saturation of 80% for days at a time, is difficult to teach to the intensive care staff.

Other areas where the use of ECMO is being investigated include cardiac arrest and septic shock. All of these topics are discussed in the excellent papers in this issue of the *Indian Journal of Thoracic and Cardiovascular Surgery*. Congratulations to all the authors and editors.

Declarations

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