

# Pediatric Extracorporeal Membrane Oxygenation

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## KEYWORDS

- Pediatric extracorporeal membrane oxygenation
- Pediatric extracorporeal life support • Centrifugal technology • Fluid overload
- Nutrition

## KEY POINTS

- Pediatric extracorporeal membrane oxygenation (ECMO) is a growing field.
- Many centers started with roller pumps but have transitioned to centrifugal pumps.
- Modes of support include venovenous for respiratory support and venoarterial for cardiac support.
- Diuretics, slow continuous ultrafiltration, and continuous renal replacement can be used to manage fluid overload.
- Provide adequate nutrition, preferably use the enteral route if possible.

## INTRODUCTION

Extracorporeal life support (ECLS), commonly referred to as extracorporeal membrane oxygenation (ECMO), is a modified form of cardiopulmonary bypass. Venous blood is drained from the patient and advanced to a membrane lung for gas exchange. Oxygenated blood is then returned to the patient through a large vein (called venovenous or VV ECMO) or artery (called venoarterial or VA ECMO). Although ECMO was attempted early on in adults, failure to demonstrate any benefit cooled any enthusiasm for the technique, and it was largely abandoned for adults until recently. Experience in ECMO has come largely from the neonatal and pediatric population.

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Disclosure Statement: Dr H.J. Dalton discloses that she is a consultant for Innovative ECMO Concepts Inc, rEVO biologics and has provided speaker support for Maquet Inc.

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Crit Care Clin ■ (2017) ■-■

<http://dx.doi.org/10.1016/j.ccc.2017.06.005>

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In 1975, the work of Robert Bartlett and colleagues propelled ECMO forward by supporting the first neonate with persistent pulmonary hypertension.<sup>1</sup> After this initial experience, others also pioneered ECMO support in infants. Although premature infants had a high incidence of intracranial hemorrhage, term infants did well. Several randomized trials in the United States and the United Kingdom found that ECMO support improved outcomes when compared with conventional care<sup>2</sup> and it has become accepted practice in neonatal care.

As experience with neonatal ECMO grew, application to children outside the infant period began to expand. Most information on the use of ECMO comes from the Extracorporeal Life Support Organization (ELSO) international registry. Of the more than 80,000 patients reported, more than 8000 pediatric patients with respiratory failure have received ECMO support and 9300 have been supported for cardiac dysfunction. **Table 1** outlines outcomes based on diagnosis from the ELSO registry. All centers should report data to ELSO and follow center-specific reports for quality improvement and benchmarking. Recent advancements in technology have been associated with expansion to more complex patient populations. The following will describe current technology, management complications, and future needs of these critically ill children.

## EQUIPMENT AND EXTRACORPOREAL MODES

### *Circuit*

Blood is drained from the patient to a pump that advances blood to a membrane lung. Gas exchange, which removes carbon dioxide and adds oxygen to the blood, occurs and the oxygenated return is directed back into the patient via a large cannula placed in a vein or artery. As membrane lungs have become very low resistance and efficient, ECMO also can be performed in some circumstances without need for a pump. In this circumstance (pumpless ECMO), the patient's native blood pressure drives blood from an arterial source through the circuit and membrane lung and back in to the venous circulation. This mode also can be used in patients with severe pulmonary hypertension, as pressure from the right ventricle can drive blood through a cannula placed in the pulmonary artery to the membrane lung and oxygenated return directed into the left side of the heart or the aorta. Conversely, if a patient has adequate pulmonary function and just needs circulatory support, the membrane lung can be omitted and the ECMO circuit used for hemodynamic support.

### *Roller Pumps*

In the early days of ECMO, most centers used a roller head located with an enclosed box termed "pump housing."<sup>3</sup> Roller pumps advance blood through the circuit tubing

**Table 1**  
ECLS registry report: January 2017

| Pediatric   | Total Patients | Survived ECLS |            | Survived to DC or Transfer |            |
|-------------|----------------|---------------|------------|----------------------------|------------|
|             |                | Total Number  | Percentage | Total Number               | Percentage |
| Respiratory | 8070           | 5424          | 67         | 4632                       | 57         |
| Cardiac     | 9362           | 6404          | 68         | 4758                       | 50         |
| ECPR        | 3399           | 1958          | 57         | 1414                       | 41         |

*Abbreviations:* DC, discharge; ECLS, extracorporeal life support; ECPR, extracorporeal cardiopulmonary resuscitation.

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