

2018 AmSECT **pediatric** October 4-6, 2018 | Miami, FL 

Pediatric ECPR

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Extracorporeal Cardio-Pulmonary Resuscitation

- ECPR was first reported in 1992
- It was used to aid in-hospital cardiac arrest after cardiac surgery
- This led to remarkable improvement in survival compared to Conventional CPR (C-CPR)

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- Refractory cardiac arrest is defined by the lack of spontaneous circulation within a period of at least 30 minutes of CPR in the absence of preexisting hypothermia
- 30 minutes of CPR has a return to spontaneous circulation rate of about 7-10 % and 60 minutes of CPR is close to 0
- The overall survival with ECPR is close to 40%

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- ECPR evolved due to recognition of poor rate of recovery from cardiac arrest following external chest compression
- The technique involves rapid institution of ECLS during cardiac arrest via percutaneous cannulation of femoral vessels or through a reopened sternotomy and mediastinal cannulation
- Many institutions keep one or more pre-primed ECLS circuits on permanent standby to facilitate ECPR.
- These circuits can be kept sterile for up to 30 days

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- ECPR is the most rapidly growing application of ECLS and has been used more frequently in pediatrics than in neonates or adults until recently
- ECPR requires considerable resources, coordination, and organization to perform effectively and should be regarded as one of the most challenging indications for ECLS
- In most centers the survival is less than 50% irrespective of age
- In the most experienced centers half the patients survive, with 75% of them having mild or no neurologic impairment

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- Although clinical and pharmacologic guidelines exist for the practice of cardiopulmonary resuscitation in children (Pediatric Advanced Life Support), the practice of extracorporeal cardiopulmonary resuscitation in pediatric cardiac patients remains without universally accepted standards
- Team make-up, training and logistics
- PCICU>PICU>NICU>ER

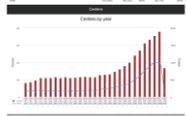
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- Vascular cannulation is one of the most challenging aspects of ECPR
- Can be the greatest constraint to providing ECPR
- Traditional approach has been an open surgical approach with vessel ligation
- Percutaneous approaches are replacing surgical approaches in some situations when patients are greater than 15 kg.

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ECLS Registry Report

	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Number of cases	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Survival	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Neurologic impairment	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%



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Indications

AHA guidelines for CPR recommends consideration of ECMO to aid cardiopulmonary resuscitation in patients who have an easily reversible event, have had excellent CPR.

Contraindications: All contraindications to ECMO use (such as Gestational age < 34 weeks) should apply to ECPR patients. DNR orders

Futility: Unsuccessful CPR (no return of spontaneous circulation) for 5-30 minutes.

ECPR may be indicated on prolonged CPR if good perfusion and metabolic support is documented.

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Initiation of flow

Once cannulation is achieved ECMO circuit management should continue as for all other ECMO uses. Because ECPR required rapid cannulation and ECMO access, correct connection of the arterial and venous cannulae to the corresponding limbs should be checked using a "Time-Out" system prior to ECMO flow.

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Patient Management

CNS protection during and after CPR is critical. Therapies known to improve survival and CNS outcomes after CPR such as:

Total body hypothermia may be included. Cooling should be achieved by applying ice to the head during CPR and for 24 – 72 hours after ECMO cannulation.

Neurological exams should be performed following discontinuation of neuromuscular blocking agents after hemodynamic stability is achieved in collaboration with the neurologist.

Management of Left Atrial Hypertension: Evaluation for LA hypertension should be undertaken soon after the patient is placed on ECMO and LA decompression should be considered if left atrial pressure is thought to be elevated.

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Diagnosis Procedures including:

ECHO or cardiac catheterization or other imaging or laboratory test should be undertaken when the patient if has stable ECMO flows and perfusion, to evaluate the cause of cardiac arrest if once cannot be determined immediately

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- Extracorporeal Cardiopulmonary Resuscitation (E-CPR) During Pediatric In-Hospital Cardiopulmonary Arrest Is Associated With Improved Survival to Discharge: A Report from the American Heart Association's Get With The Guidelines-Resuscitation (GWTG-R) Registry. Lasa, Javier J et al January 2016
- Conclusion—: For children with in-hospital CPR of ≥ 10 minutes duration, E-CPR was associated with improved survival to hospital discharge and survival with favorable neurological outcome compared with C-CPR

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Characteristics, Risk Factors, and Outcomes of Extracorporeal Membrane Oxygenation Use in Pediatric Cardiac ICUs: A Report From the Pediatric Cardiac Critical Care Consortium Registry, Brunetti, Marissa A. Md et al June 2018

- 449 (3.1%) extracorporeal membrane oxygenation run
- 329 surgical (3.5%) and 120 medical (2.4%) hospitalizations.
- Systemic circulatory failure and extracorporeal cardiopulmonary resuscitation were the most common ECLS indications.
- In the surgical group, risk factors associated with postoperative extracorporeal membrane oxygenation use included younger age, extracardiac anomalies, preoperative comorbidity, higher Society of Thoracic Surgeons-European Association for Cardiothoracic Surgery category, bypass time, postoperative mechanical ventilation, and arrhythmias (all $p < 0.05$).
- Bleeding requiring reoperation (25%) was the most common extracorporeal membrane oxygenation complication in the surgical group. In the medical group, risk factors associated with extracorporeal membrane oxygenation use included acute heart failure and higher Vasoactive Inotropic Score at cardiac ICU admission (both $p < 0.0001$).
- Stroke (15%) and renal failure (15%) were the most common extracorporeal membrane oxygenation complications in the medical group.

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- Hospital mortality was 49% in the surgical group and 63% in the medical group; mortality rates for hospitalizations including ECPR were 50% and 83%, respectively.
- Conclusions: This is the first multicenter study describing extracorporeal membrane oxygenation use and outcomes specific to the cardiac ICU and inclusive of surgical and medical cardiac disease. Mortality remains high, highlighting the importance of identifying levers to improve care. These data provide benchmarks for hospitals to assess their outcomes in extracorporeal membrane oxygenation patients and identify unique high-risk subgroups to target for quality initiatives.

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Other indications for ECPR

- Pulmonary failure
- Myocarditis
- Pulmonary embolism
- Sepsis
- Ingestions
- Hypothermia
- Out of hospital

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ECPR study comparing weekdays with night/weekends

Interval from **ECPR** activation to initiation of extracorporeal life support was significantly longer during night/weekends (49min night/weekend vs. 33min weekday, $p<0.001$) as was the interval from **ECPR** activation to incision for cannulation (26min night/weekend vs. 14min Weekday, $p<0.001$). Rate of central nervous system (CNS) injury was higher in the night/weekend group (43% night/weekend vs. 15% weekday, $p=0.04$), with associated 75% mortality prior to hospital discharge. Time of arrest did not impact survival to hospital discharge (44% night/weekend vs. 55% weekday, $p=0.57$), one-year survival (33% night/weekend vs. 44% weekday, $p=0.44$), or neurologic outcome (**Pediatric** Cerebral Performance Score at 1-year post-**ECPR**, 1.45 weekday vs. 1.50 night/weekend, $p=0.82$).

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Conclusions

Cardiac arrest occurring at night or during weekend hours is associated with a longer **ECPR** initiation time and higher rates of CNS injury. However, prolonged pre-**ECPR** support associated with off-hours cardiac arrest does not appear to impact survival or functional outcome in **pediatric** patients.



