CONGRESSO NAZIONALE IRC 2023

Vicenza

Italian Resuscitation Conference 2023

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LA RIVOLUZIONE DEI SISTEMI

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ECMO e ECLS : la gestione pediatrica

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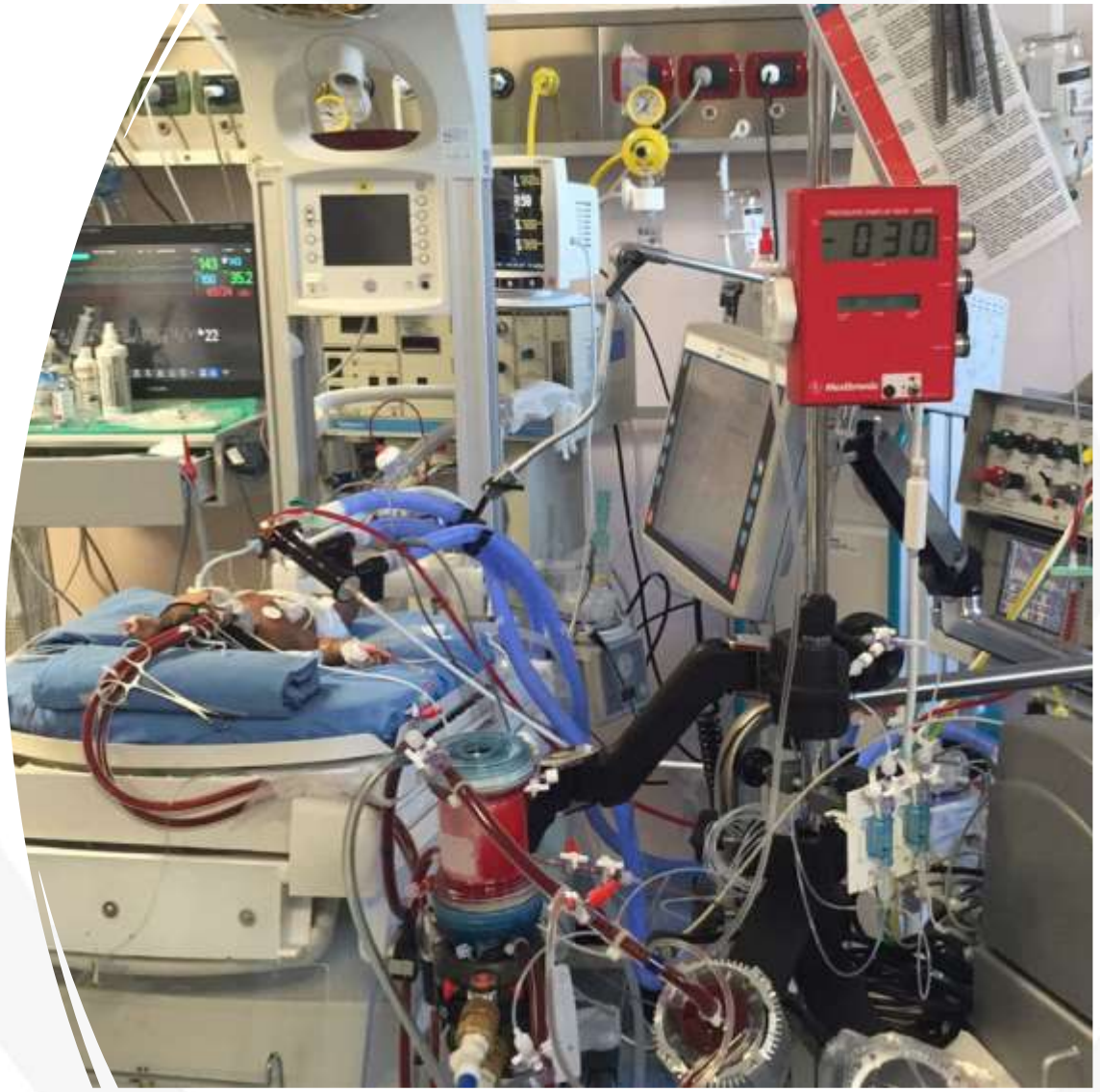
MA
GNVM
CHA
OS

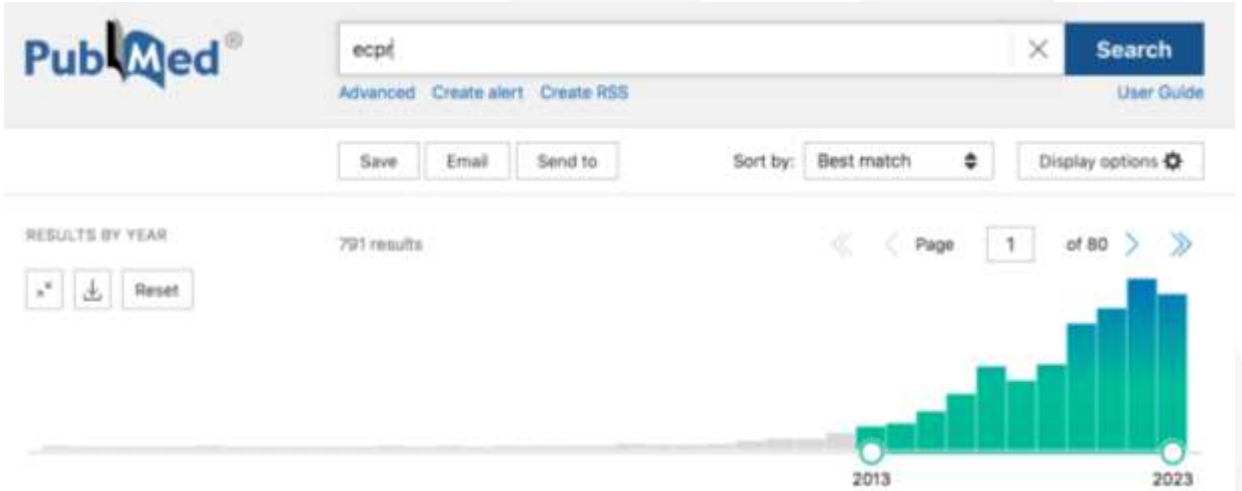
Extracorporeal life support (ECLS), also known as extracorporeal membrane oxygenation (ECMO), is essentially a functioning heart and lung machine for a patient in whom their own anatomy or physiology is impaired.

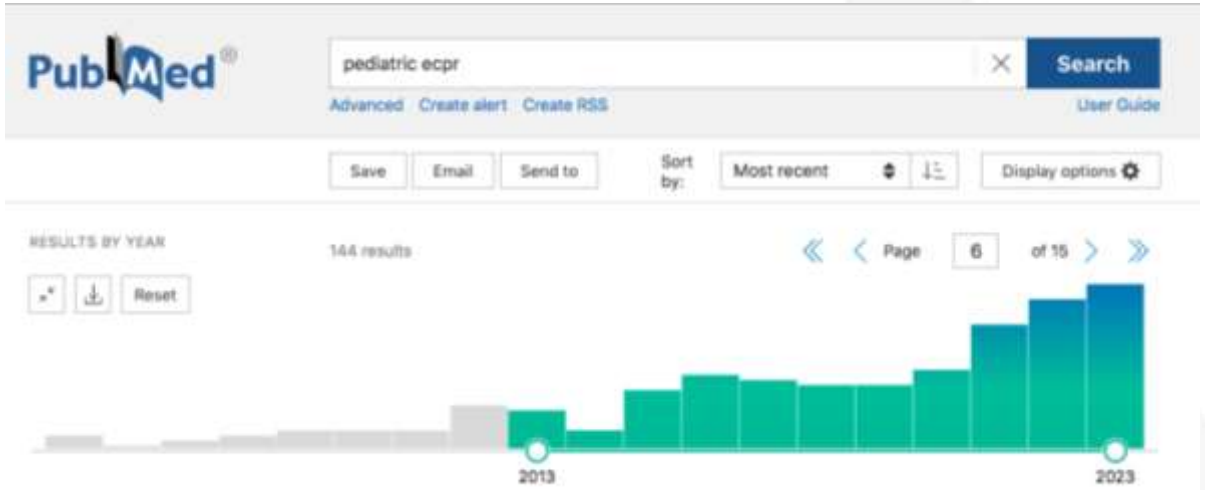
ECMO can be used for many different pathologies, which may require either venovenous (VV) or venoarterial (VA) for the support of the patient.

ECMO can provide a bridge for the patient to resolve their disease process or provide the patient time to receive a long-term device or transplant.



2013: 20
2022: 165
2023:150





2013: 7
2022:29
2023:32

Circulation. 1992 Nov;86(5 Suppl):II300-4.

Extracorporeal membrane oxygenator rescue in children during cardiac arrest after cardiac surgery

P J del Nido [1], H J Dalton, A E Thompson, R D Siewers

Conclusions: We conclude that ECMO rescue in children with postcardiotomy cardiac arrest is a feasible option in selected patients even after prolonged CPR (as long as 60 minutes).

RESUSCITATION 161 (2021) 327 –387

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Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

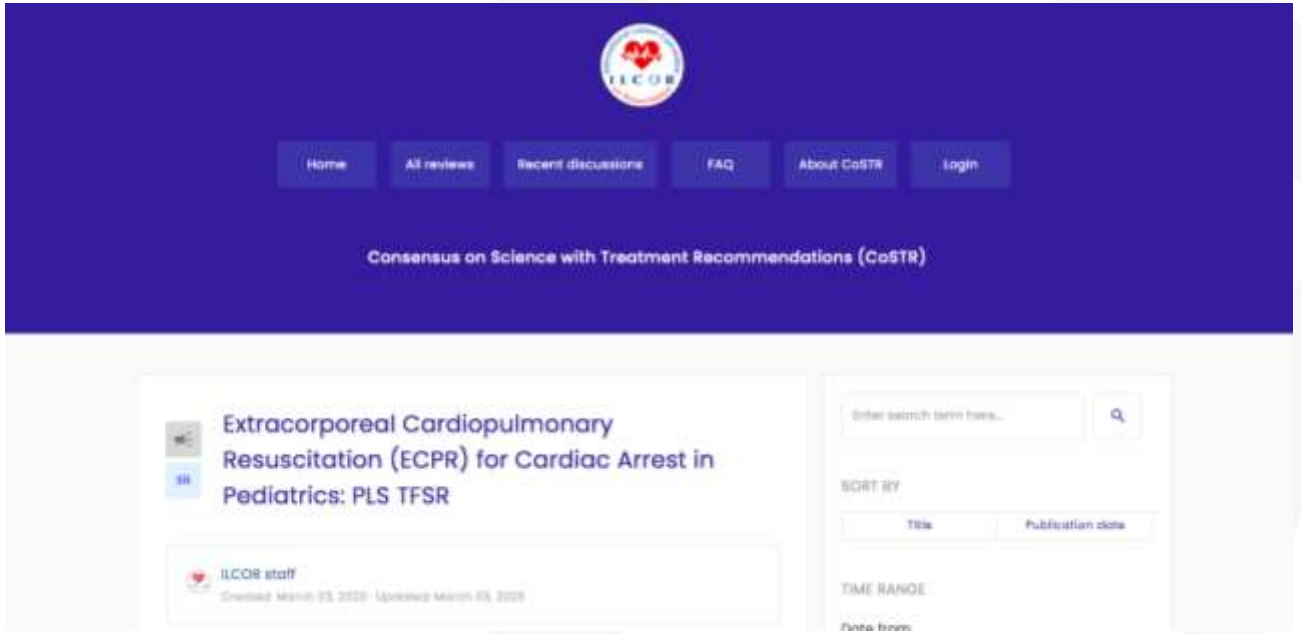
European Resuscitation Council Guidelines 2021: Paediatric Life Support

Patrick Van de Voorde[a,b,], Nigel M. Turner[c], Jana Djakow[d,e], Nieves de Lucas[f], Abel Martinez-Mejias[g], Dominique Biarent[h], Robert Bingham[i], Olivier Brissaud[j], Florian Hoffmann[k], Groa Bjork Johannesdottir[l], Torsten Lauritsen[m], Ian Maconochie[n]*

"changes the concept of reversibility "

Extracorporeal eCPR

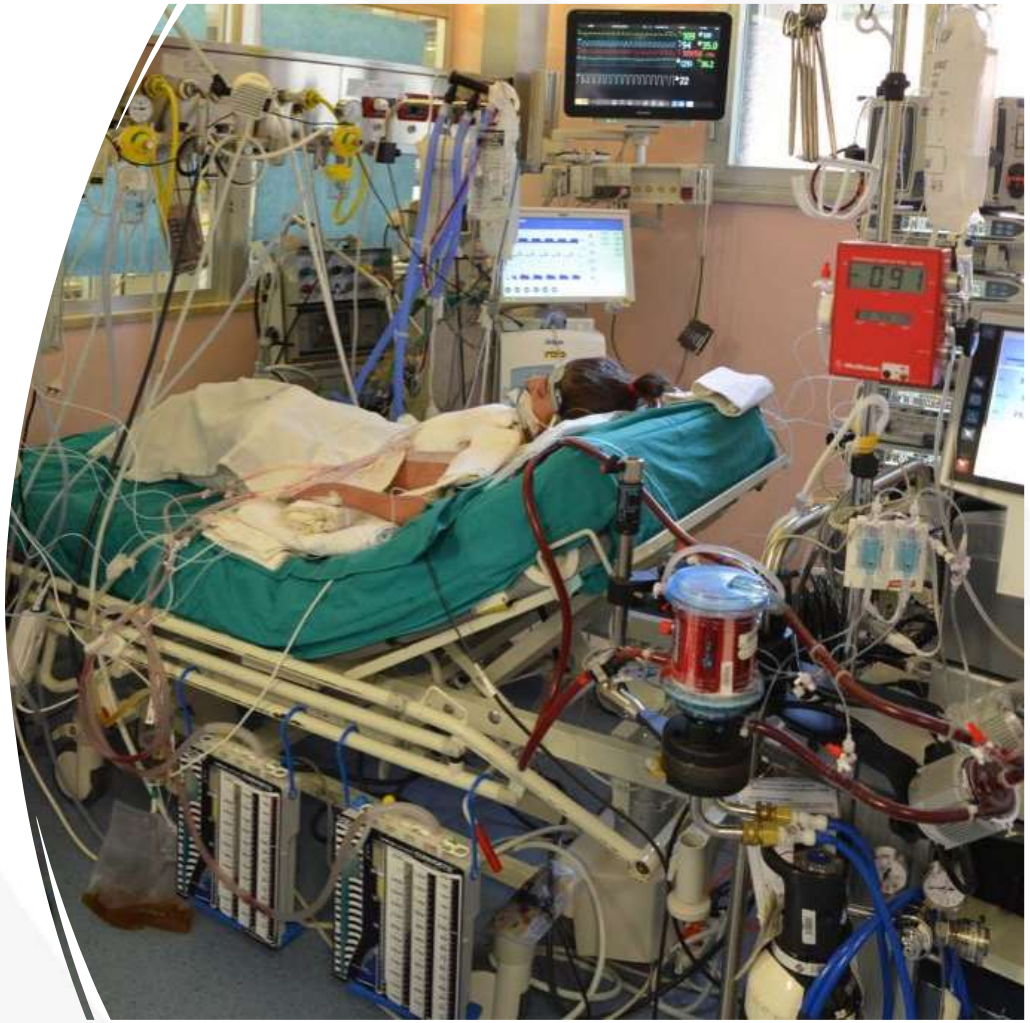
In line with the ILCOR 2019 COSTR update on the use of eCPR in children, we advise considering eCPR for children with ED- or IHCA with a presumed or confirmed reversible cause where conventional ALS does not promptly lead to ROSC (weak recommendation, very low certainty evidence).[697] An essential precondition is the organisational setting i.e. *with a strong institution-based commitment to sustaining a resuscitation system that includes eCPR with appropriate quality improvement systems.* To make a realistic choice about the use of eCPR, systems should also consider the evidence on cost-efficiency (see chapter on ethics).[695] Given the high resources needed and the fact that outcome is related to time to initiation and quality of CPR before initiation, the indications for eCPR in OHCA are very limited (appendix RR 33.3).[794–798]



"We suggest that ECPR may be considered as an intervention for **selected infants and children** (e.g., pediatric cardiac populations) with **IHCA refractory to conventional CPR**, in settings where resuscitation systems allow ECPR to be well performed and implemented (weak recommendation, very low-quality evidence).
There is **insufficient evidence in pediatric OHCA** to formulate a treatment recommendation for the use of ECPR. "

"changes the concept of reversibility "

Pieter Paul Rubens 1605



When is ECPR?

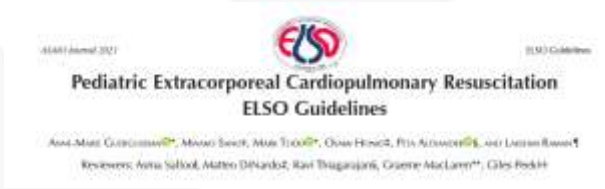
ASAIO Journal 2021

Pediatric Extracorporeal Cardiopulmonary Resuscitation ELSO Guidelines

ANNE-MARIE GUERGUERIAN*, MINAKO SANO†, MARK TODD*, OSAMI HONJO‡, PETA ALEXANDER§, AND LAKSHMI RAMAN¶

Reviewers: Asma Sallooll, Matteo DiNardo#, Ravi Thiagarajan§, Graeme MacLaren**, Giles Peek††

" When ECMO flow is instituted during conventional CPR, delivered with manual or mechanical compressions, or within 20 min of return of spontaneous circulation without ongoing compressions"



- Provide circulatory support and gas exchange
- Decrease ischemic reperfusion injury

A BRIDGE :

✓To therapy, intervention, diagnostic, transport and recovery, or
✓To organ transplant or replacement with another device, or
✓To palliative care

	Total		Total		2023 (15/10)		2023 (15/10)	
	World		Europe		World		Europe	
	Total	Survived	Total	Survived %	Total	Survived %	Total	Survived
Total	208763	54%	33098	57%	9773	53%	1105	59%
Neonates	49191	64%	6550	67%	669	55%	101	63%
Pulmonary	35353	72%	4675	74%	326	64%	53	75%
Cardiac	11124	45%	1569	48%	266	50%	35	54%
ECPR	2714	42%	302	41%	77	33%	13	38%

*World: all ELSO locations
Survived to DC or Transfer

	Total		Total		2023 (15/10)		2023 (15/10)	
	World		Europe		World		Europe	
	Total	Survived	Total	Survived %	Total	Survived %	Total	Survived
Total	208763	54%	33098	57%	9773	53%	1105	59%
Pediatric	37621	55%	6127	61%	1331	60%	206	68%
Pulmonary	13350	62%	2453	67%	442	73%	65	81%
Cardiac	17238	55%	2755	61%	636	61%	99	69%
ECPR	7033	41%	919	43%	253	36%	42	47%

*World: all ELSO locations
Survived to DC or Transfer

	Total		Total		2023 (15/10)		2023 (15/10)	
	World		Europe		World		Europe	
	Total	Survived	Total	Survived %	Total	Survived %	Total	Survived %
Total	208763	54%	33098	57%	9773	53%	1105	59%
Adult	121951	49%	20421	53%	7773	53%	798	56%
Pulmonary	53973	58%	10726	63%	2576	65%	312	68%
Cardiac	51887	46%	6496	46%	3945	50%	362	52%
ECPR	16091	30%	3199	34%	1252	32%	124	37%

*World: all ELSO locations
Survived to DC or Transfer

Table 1. Studies Reporting Survival to Hospital Discharge in Children with Supported With ECPR and Studies Reporting Longer-term Outcome

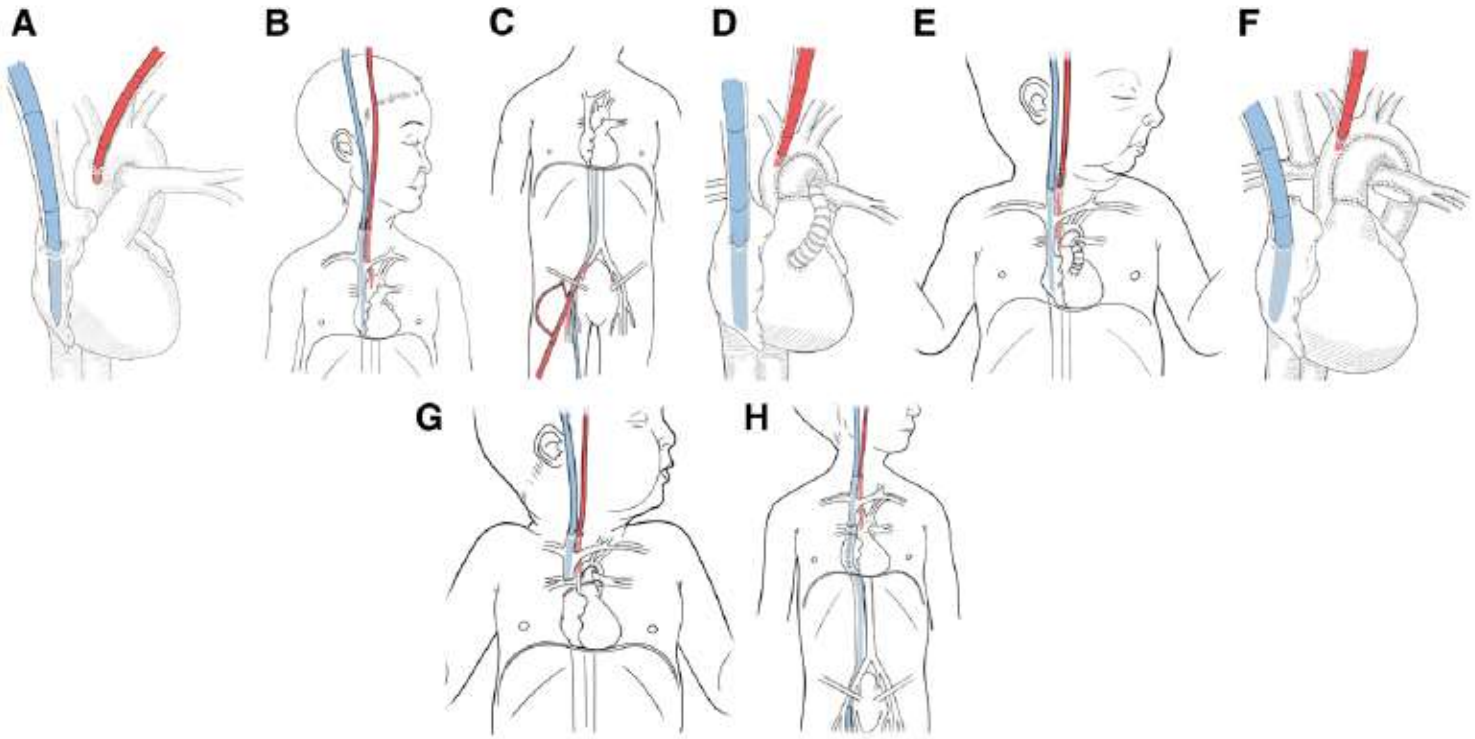
Author	Year	Diagnosis	Institution	Total	Survival
del Nido[11]	1992	Cardiac	Pittsburg	11	64%
Dalton[12]	1993	Cardiac	Pittsburg	29	45%
Duncan[13]	1998	Cardiac	Boston	11	54%
Morris[14]	2004	All	Philadelphia	64	33%
Thiagarajan[15]	2007	All	ELSO-R	682	38%
Alsoufi[16]	2007	All	Toronto	80	34%
Chen[17]	2008	All	Taiwan	27	41%
Tajik[18]	2008	All	Meta-analysis*	288	40%
Chan[19]	2008	Cardiac	ELSO-R	492	42%
Kane[20]	2010	Cardiac	Boston	172	51%
Raymond[21]	2010	All	GWTG-R	199	44%
Wolf[22]	2012	Cardiac	Atlanta	150	56%
Lasa[4]	2016	All	GWTG-R	591	40%
Meert[23]	2019	All	THAPCA	147	41%
Bembea[5]	2019	All	ELSO-R and GWTG-R	593	31%
Longer-term outcomes studies with ECPR pediatric patients					
Lequier[24]	2008	Cardiac	Edmonton	9 ECPR (of 39)	At 2 years
Garcia Guerra[25]	2015	All (2000–2010)	Edmonton	55 ECPR	43% at 4.5 years
Kuraim[26]	2018	Cardiac	Edmonton	Some ECPR	variable
Meert[27]	2019	All	THAPCA	147 ECPR	41.5% at 1 year

Children with cardiac disease may have limitation to effectiveness of conventional CPR

- Limited stroke volume with chest compressions
  => AV regurgitation, restrictive miocardium

- Limited effective pulmonary blood flow and oxygenation with compressions
- => Pulmonary outflow obstruction, elevated PVR, cavo-pulmonary connection

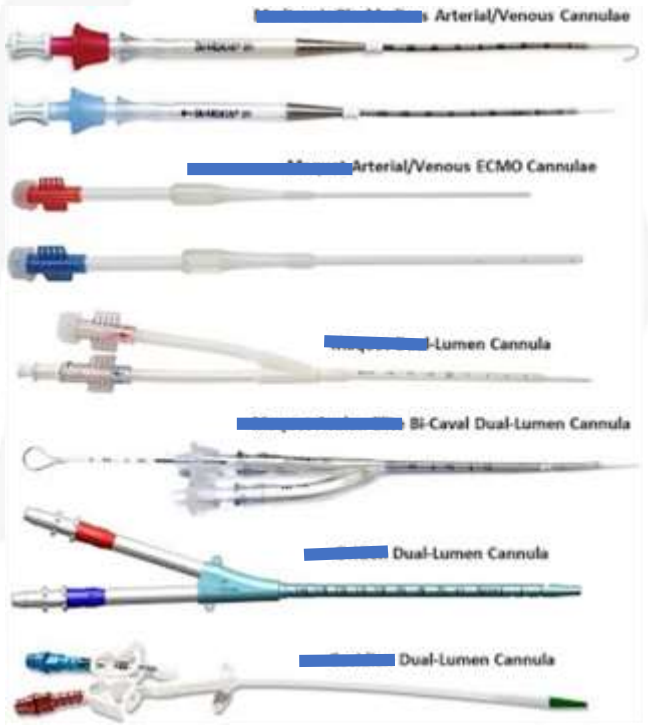
- Aorto-pulmonary run off across a shunt


A
B
C
D
E
F
G
H

VASCULAR ACCESS AND CANNULATION

Cannulation for ECPR must be achieved RAPIDLY:

- peripherally or centrally
- open surgical or percutaneous technique
- hybrid approach



Survival to hospital discharge for children is higher compared to adults

- ECPR is largely offered to children who are **in-patients** and **in ICU** environments
- Significantly **shorter times** between the start of cardiac arrest to return of extracorporeal circulation and
- **Cannulation strategies** that more often use neck or central vessels compared to femoral access
- Early neurologic assessment at hospital discharge suggests good **neurologic outcomes**

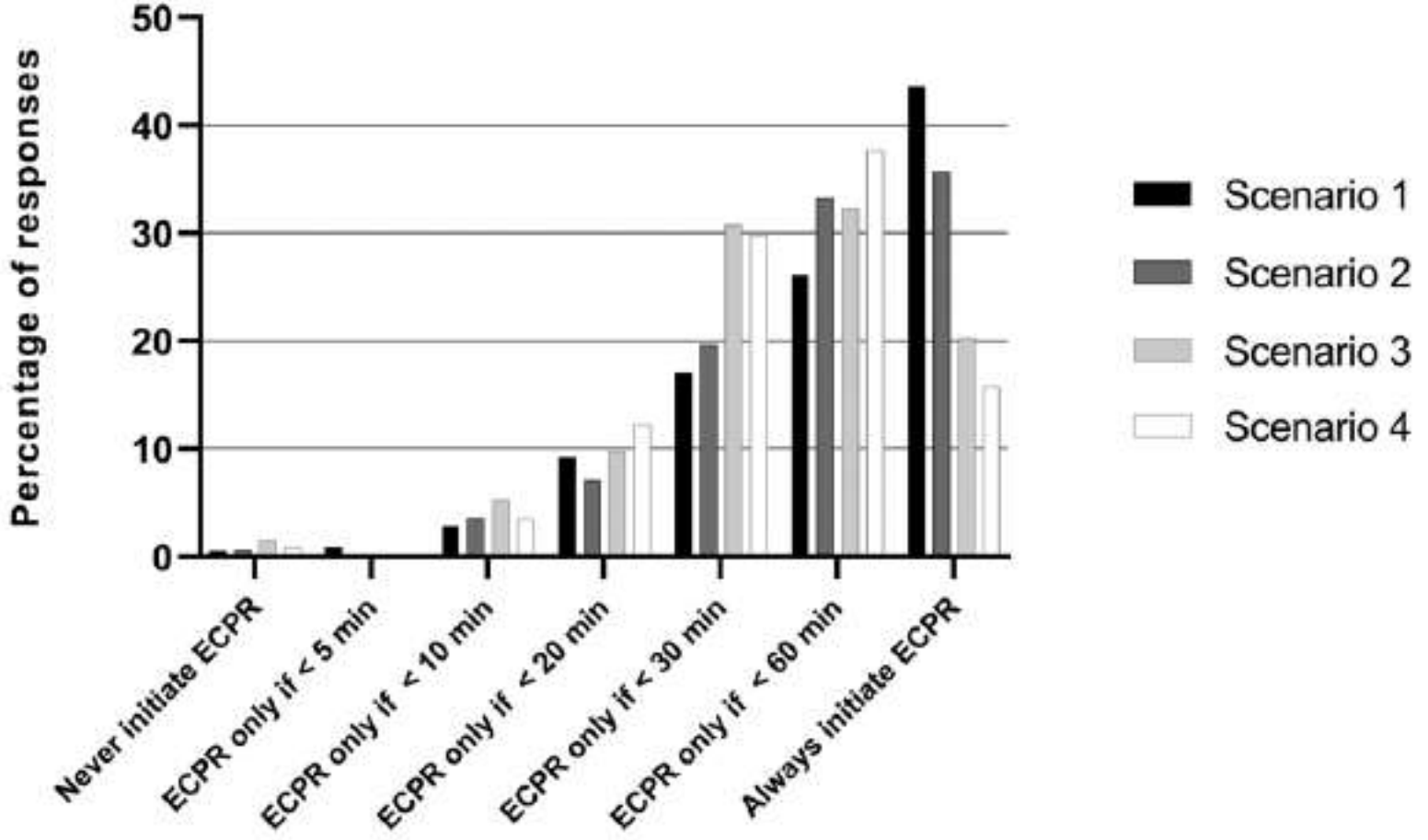
Factors Associated With Initiation of Extracorporeal Cardiopulmonary Resuscitation in the Pediatric Population: An International Survey

Duy-Anh Nguyen,*† Aurélie De Mul,†‡ Aparna U. Hoskote,§ Paola Cogo,¶ Eduardo M. da Cruz,‖ Simon Erickson,# Javier J. Lasa,** Ravi R. Thiagarajan,†† Melania M. Bembea,‡‡ and Oliver Karam,§§ on behalf of PALISI, ESPNIC, ANZICS PSG

249 pediatric critical care physicians

Table 1. The Four Cardiac Arrest Scenarios

Acute cardiac diagnosis	1-year-old patient, who just underwent heart surgery, develops a refractory cardiac arrest in the PICU. There is no bleeding involved.
Chronic cardiac diagnosis	1-year-old patient, admitted to PICU for cardiac failure secondary to viral myocarditis, develops a refractory cardiac arrest.
Noncardiac acute diagnoses	1-year-old patient, admitted to the ER for refractory septic shock, develops subsequent refractory cardiopulmonary arrest.
Noncardiac chronic diagnosis	1-year-old patient, with a history of prematurity and chronic respiratory failure secondary to bronchopulmonary dysplasia, admitted to the ER for refractory cardiopulmonary arrest.


Percentage of responses
50
40
30
20
10
0
Never initiate ECPR
ECPR only if < 5 min
ECPR only if < 10 min
ECPR only if < 20 min
ECPR only if < 30 min
ECPR only if < 60 min
Always initiate ECPR
Scenario 1
Scenario 2
Scenario 3
Scenario 4

Out Of Hospital Cardiac Arrest

- **Insufficient data** to support the recomendation either applied in the field or in the hospital after ongoing conventional CPR during transport
- To rewarm and resume circulation in hypothermic victims (submersion in water or avalanches)
- Neurologic consequences of indeterminate or prolonged hypoxic-ischemic injury may not be reversible

EQUIPMENT AND PRIMING SOLUTIONS FOR ECPR

EPCR systems require equipment that is stored “ready” for rapid mobilization

- Pre- assembled dry or wet prime circuits
- Centrifugal or roller pumps
- ECPR systems include a heat exchanger

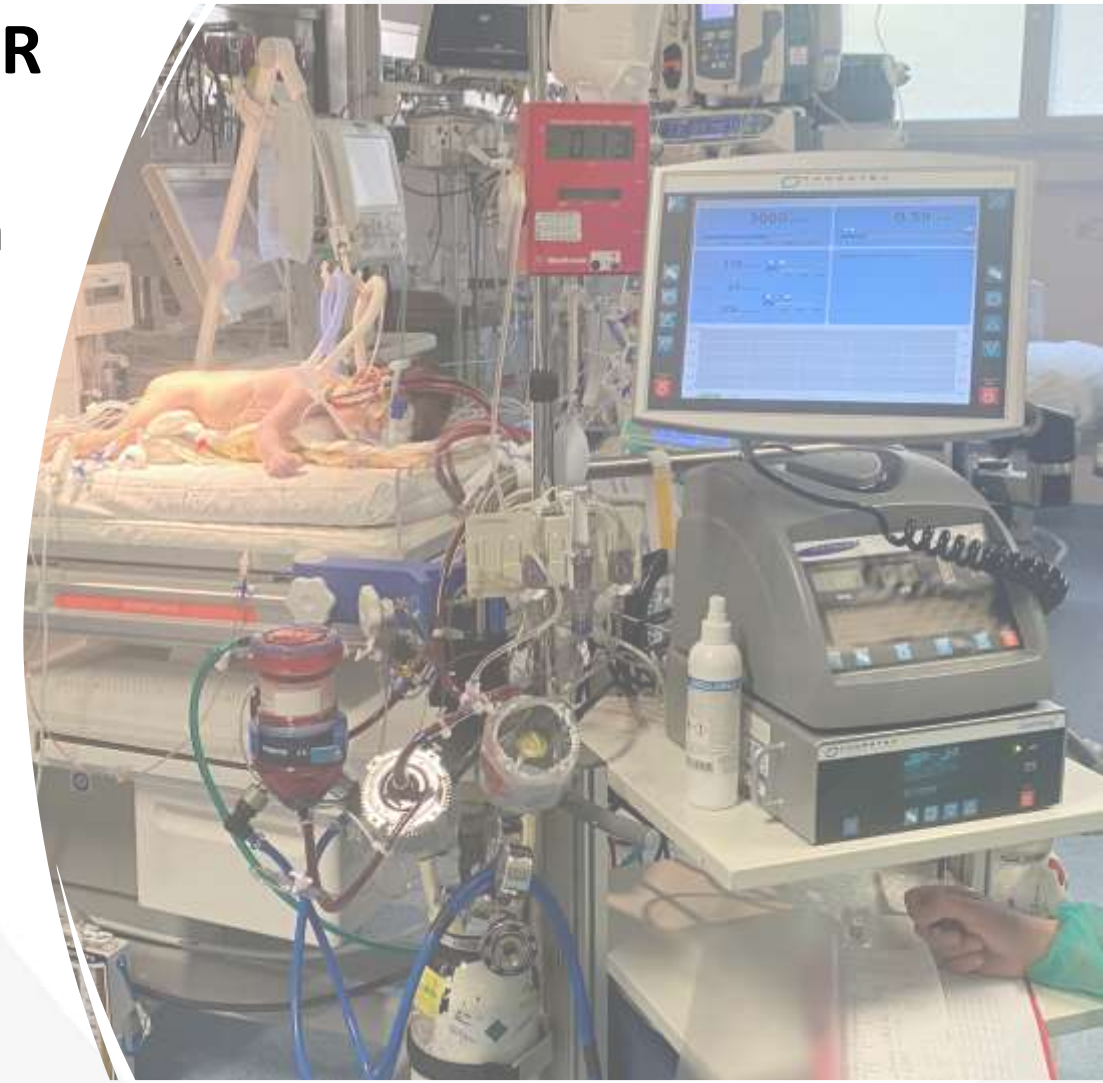
There‘s no evidence to support one priming method above another

DELAY IN ECMO DEPLOYMENT WHILE AWAITING THE AVAILABILITY OF BLOOD FOR PRIMING IS NOT CURRENT PRACTICE

Postcardiac Arrest Care following ECPR

Begins immediately after the return of circulation and gas exchange has been established

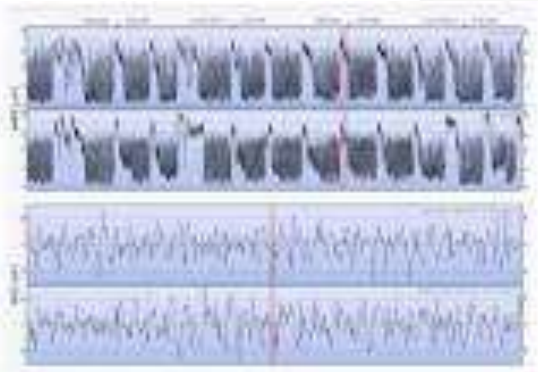
- Establish adequate ECMO flow
- Wean inotropic support as much as tolerated to avoid increased LV afterload
- TTM and potentially maintain hypothermia 33-34 C for 24-48 hrs – hyperthermia should be avoided

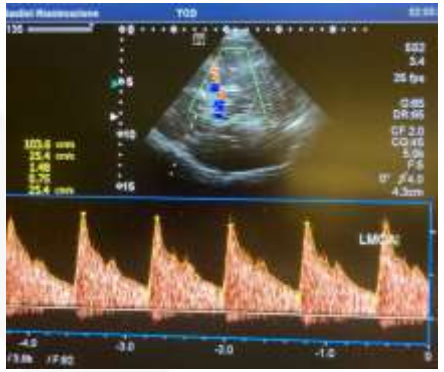


Diagnostic and Therapeutic Procedures

Include radiologic imaging and interventional cardiac catheterization to be planned and safely undertaken without delay

Risk of **neurologic injury** is greater with ECPR patients compared to ECMO patients





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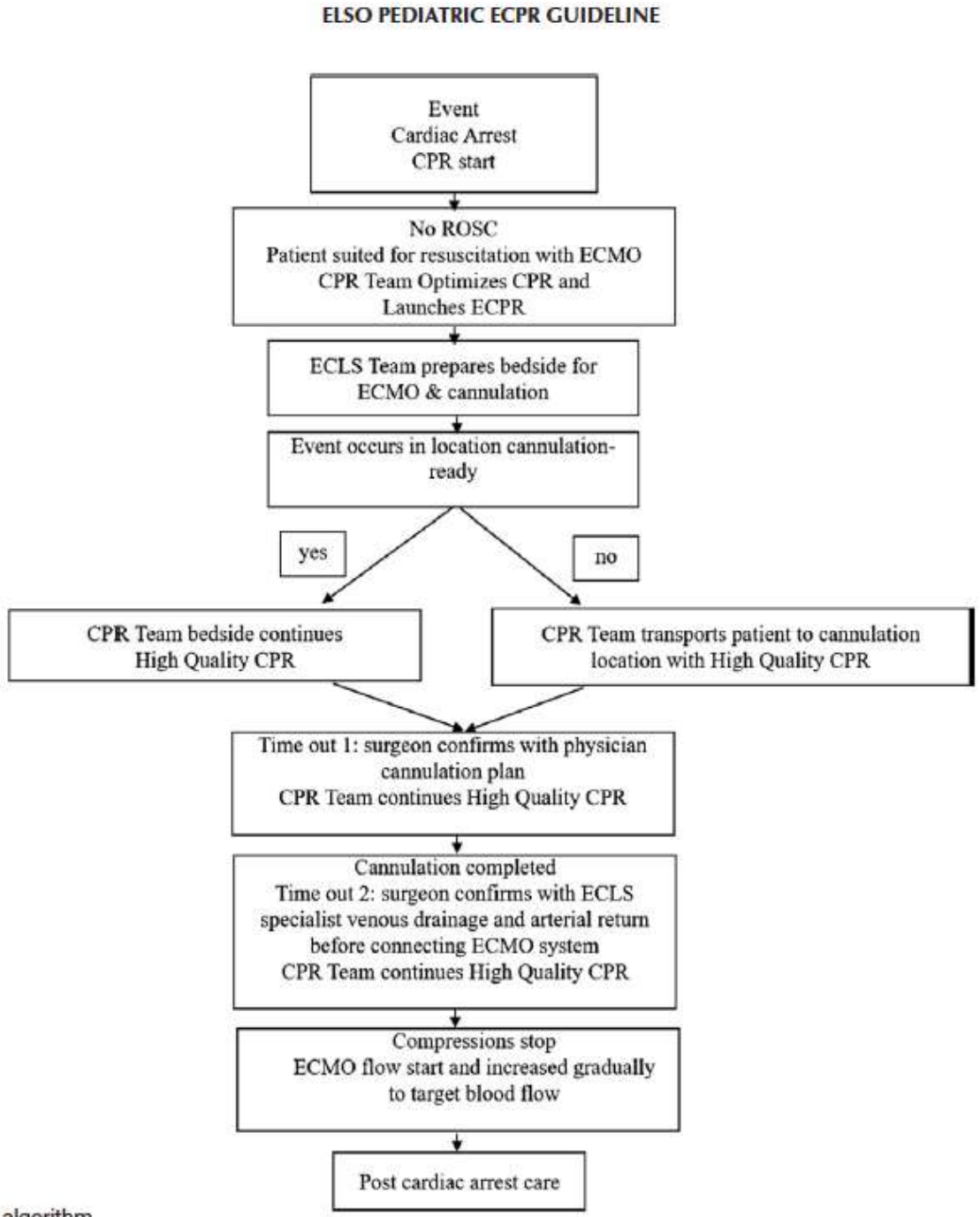

2. ECPR algorithm.

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The TEAM

Standard high–quality CPR with minimal interruptions

A **Team** of skilled providers with **rapid cannulation** and preparation of the **ECMO circuit** dedicated to ECPR

A **Team calling system** to efficiently mobilize the entire ECPR team and resources

Available 24/7

Table 2. Tasks and Team Members With Predefined Roles and Responsibilities

Unit Type and Event Location	ICU Cannulation-ready Location	Non-ICU Cannulation-ready Location	Non-ICU Not Cannulation Location
Predefined cannulation locations	Cannulation equipment and footprint approved room	Cannulation equipment and footprint approved: • Image-Guided Laboratory • Cardiac Catheterization Laboratory • Operating Rooms	Cannulation equipment not available and footprint not approved: • Inpatient wards • Out-patient clinics, NICU, Emergency Department, Diagnostic Imaging, and Remote anesthesia locations (*e.g.*, MRI)
Tasks	Members responsible for task		
Start Resuscitation	Bedside clinician (ICU nurse or physician)	Bedside clinician (ICU nurse or physician)	Clinician witness pages Stat Code Blue Team
Stat ECMO Team page	ICU physician faculty or Charge Nurse or delegate	ICU physician faculty or Anesthesia faculty	ICU physician faculty or delegate
Event manager	ICU physician 1	ICU physician	ICU physician
CPR team leader	ICU physician 2	Anesthesia faculty	CCRT or ICU fellow
Conventional High-quality CPR	ICU CPR Team	Anesthesia CPR Team	Intra-hospital transport with ongoing CPR to cannulation-ready location
ECMO vessel cannulation	CVS surgeon 1 (in-house) CVS surgeon 2	CVS surgeon 1 (in-house) CVS surgeon 2	CVS surgeon 1 (in-house) CVS surgeon 2
ECMO circuit	ECMO specialist 1 (in-house) Perfusion specialist 1 or ECMO specialist 2	ECMO specialist 1 (in-house) Perfusion specialist 1 or ECMO specialist 2	ECMO specialist 1 (in-house) Perfusion specialist 1 or ECMO specialist 2
CPR medications Compressions	Bedside and medication nurses 2 assigned	Bedside and medication nurses 2 assigned	Bedside and medication nurses 2 assigned
Heparin bolus	ICU staff physician and ECMO specialist double checks	ICU staff physician and ECMO specialist double checks	ICU staff physician and ECMO specialist double checks
Resources	Charge or Clinical support nurse	Charge or Clinical support nurse	Charge or Clinical support nurse
Airway	Respiratory therapist once tracheal intubation established	Anesthesia second staff once tracheal intubation established	Respiratory therapist once tracheal intubation established
Documentation and clock time keeper	Documentation nurse or RT	Documentation nurse or RT	Documentation nurse or RT

ECPR is a complex multidisciplinary resuscitation modality that involves substantial resources and strong institutional commitment

Successful ECPR programs require maintenance of expertise and equipment

Simulation has been widely regarded as beneficial for ECMO team training, technical skills, provider confidence, communication and collaboration

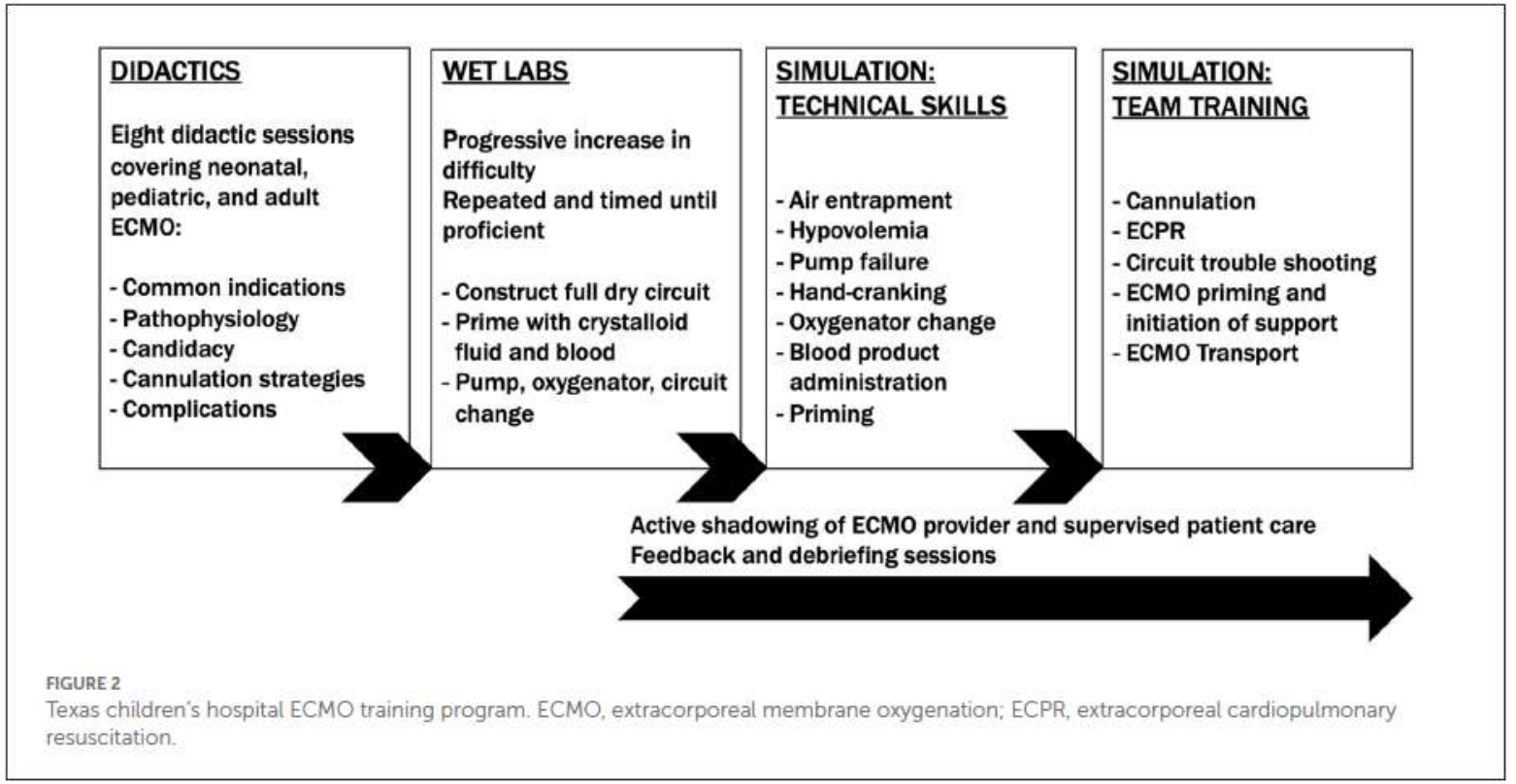

FIGURE 2
Texas children's hospital ECMO training program. ECMO, extracorporeal membrane oxygenation; ECPR, extracorporeal cardiopulmonary resuscitation.

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Thank You...