ECPR

Samphant Ponvilawan
Bumrungrad International

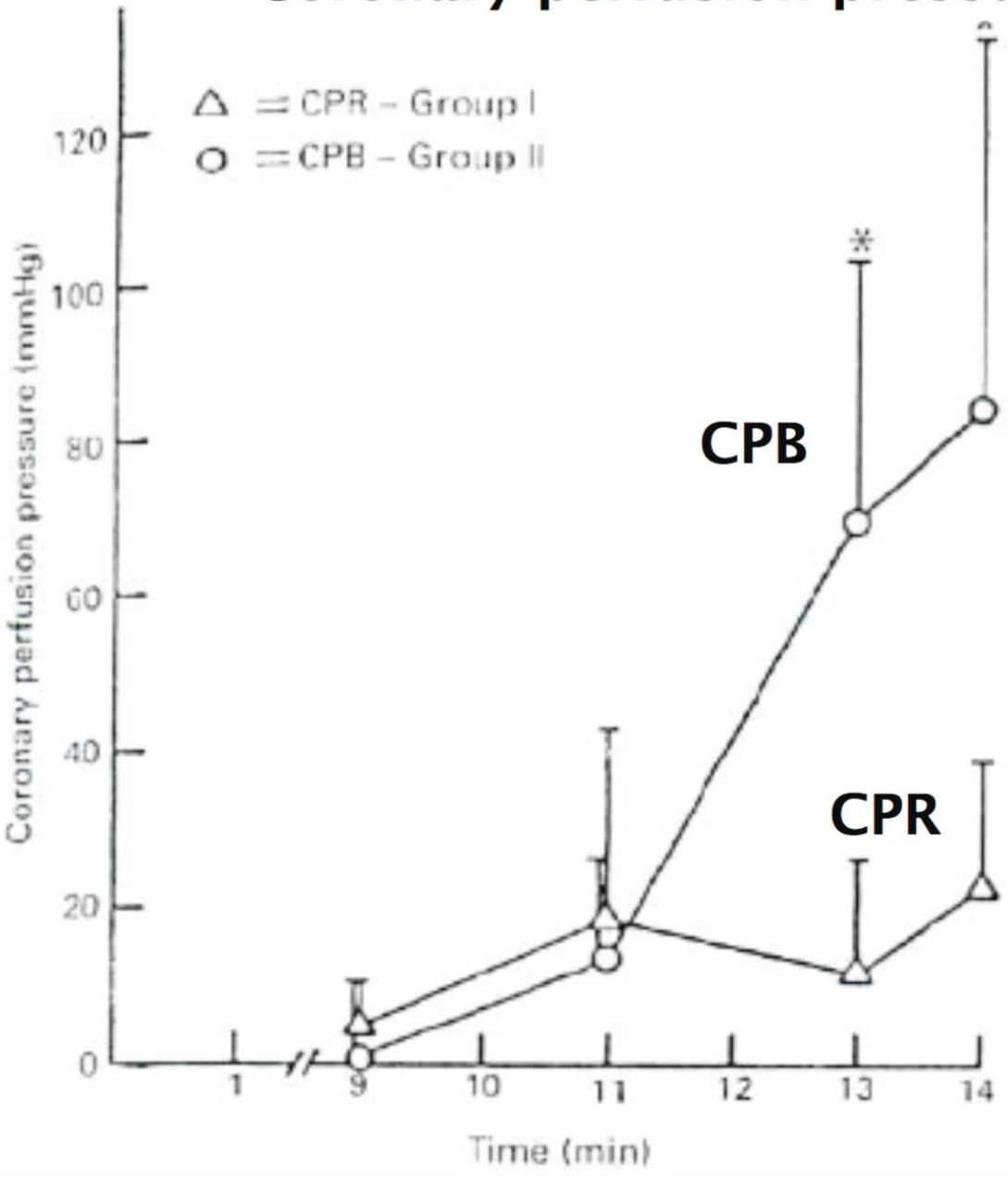
Definitions

Artificial circulation using VA ECMO as an alternative to ventilation and external cardiac massage

Indications

- Out-of-Hospital Cardiac Arrest (OHCA)
- In-Hospital Cardiac Arrest (IHCA)

Coronary perfusion pressure



Angelos 1990

Extracorporeal membrane oxygenation support can extend the duration of cardiopulmonary resuscitation*

Yih-Sharng Chen, MD; Hsi-Yu Yu, MD; Shu-Chien Huang, MD; Jou-Wei Lin, MD; Nai-Hsin Chi, MD; Chih-Hsien Wang, MD; Shoei-Shan Wang, MD; Fang-Yue Lin, MD; Wen-Je Ko, MD

Objectives: **To evaluate the use of extracorporeal membrane oxygenation in prolonged cardiopulmonary resuscitation and to estimate how long cardiopulmonary resuscitation can be extended with acceptable results.**

Design: **nary resusc lation in 10 ation rescu and cardio ologies. Th guidelines organ dysf for outcom**

Setting: **and extraco**

Patients: **adult in-hos return of s membrane**

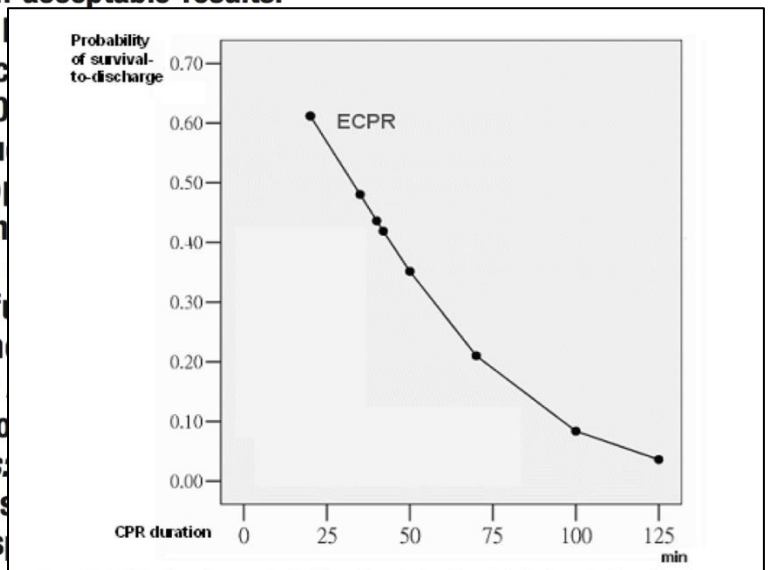


Figure 2. Relationship between probability of survival-to-hospital discharge and cardiopulmonary resuscitation (*CPR*) duration. *ECPR*, extracorporeal membrance oxygenation for CPR.

Table 6. Comparison of conventional CPR groups with ECPR groups

In-Hospital Prolonged CPR (>10 mins)	No.	Duration, Mins (Mean ± SD, Median)	Age, Yr (Mean ± SD, Median)	Survival (%)	*p*
C1, all causes	243	35.3 ± 23.9, 30[a]	56.0 ± 15.8, 59.5 (NS)	9.5[a]	<0.001
C2, cardiopulmonary origin	168	36.2 ± 24.2, 30[a]	48.8 ± 13.7, 53.5[a]	8.9[a]	<0.001
With ECMO (ECPR)	135	55.7 ± 27.0, 50	54.0 ± 15.7, 56.0	34.1	—

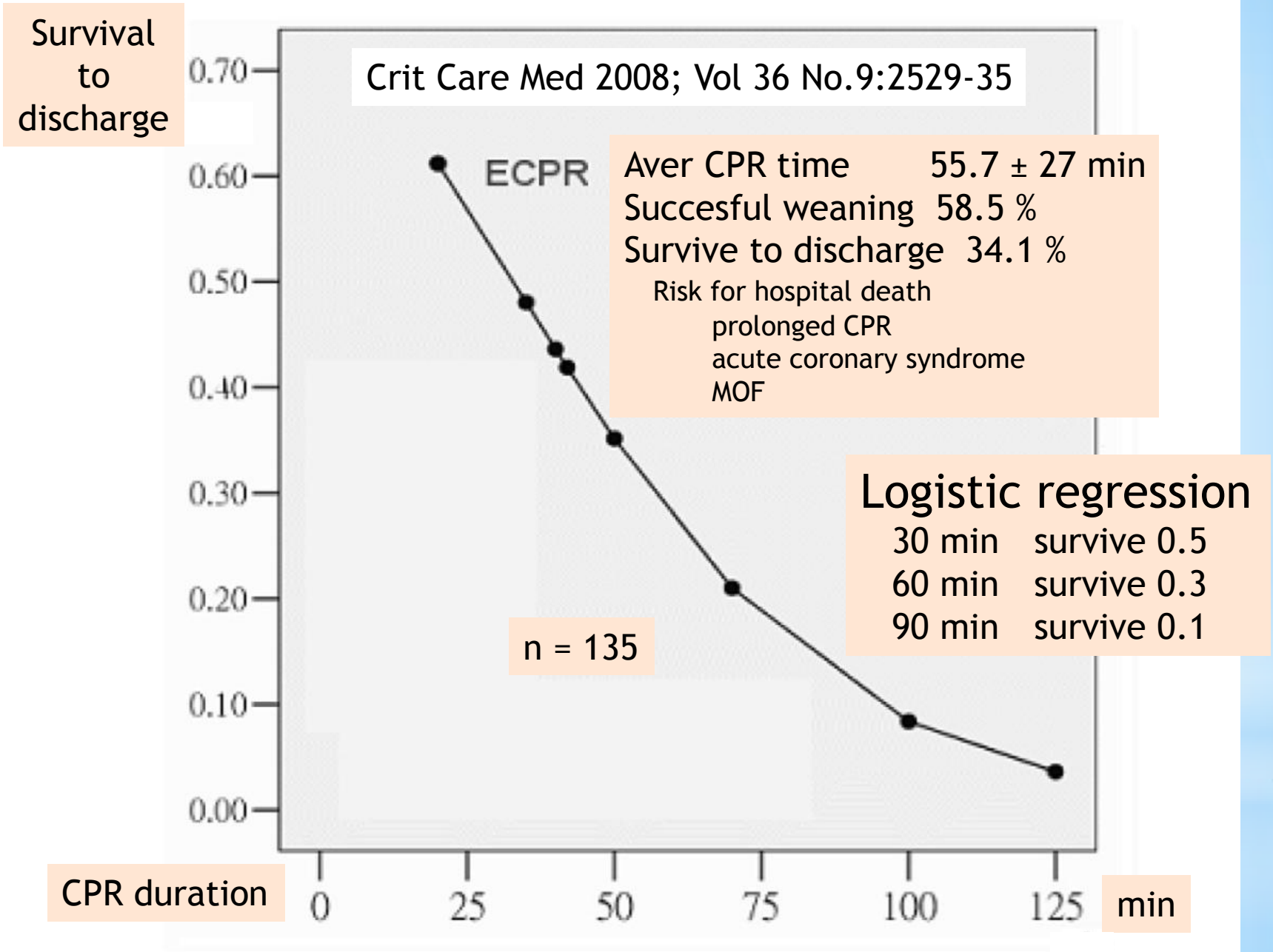
Main Results: **The average cardiopulmonary resuscitation duration was 55.7 ± 27.0 mins and 56.3% of patients received subsequent interventions to treat underlying etiologies. The successful weaning rate was 58.5% and the survival-to-discharge rate was 34.1%. The majority of survivors (89%) had an acceptable neurologic status on discharge. Risk factors for hospital mortality included longer car tion duration, etiology of acute coronary s r organ dysfunction score in the first 24 hrs. Logistic regression analysis revealed the probability of survival was approximately 0.5, 0.3, or 0.1 when the duration of cardiopulmonary resuscitation was 30, 60, or 90 mins, respectively.**

Conclusion: **Assisted circulation might extend the presently accepted duration of cardiopulmonary resuscitation in adult in-hospital cardiopulmonary resuscitation patients. (Crit Care Med 2008; 36:2529–2535)**

KEY WORDS: extracorporeal membrane oxygenation; cardiopulmonary resuscitation; in-hospital

IHCA n=135

Crit Care Med 2008; Vol 36 No.9:2529-35



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Survival

<10 % in conventional CPR

34 % with ECPR

Abstract ▾ Send to: ▾

Curr Opin Crit Care. 2014 Jun;20(3):259-65. doi: 10.1097/MCC.0000000000000098.

Extracorporeal cardiopulmonary resuscitation.

Fagnoul D[1], Combes A, De Backer D.

Author information

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Abstract

PURPOSE OF REVIEW: T

RECENT FINDINGS: Retu ion (CPR). In this context, it has been propos (IHCA) and in out-of-hospital cardiac arrest (OH

SUMMARY: This review hig n IHCA is satisfactory, with survival rates good wit cardiac arrest to ECMO flow is a critical determinan 0min, and 18% after 60 min. Results of ECPR in OI the patients, provided that time from arrest to ECM rdiac arrest. ECPR thus seems to be a valuable opt

PMID: 24785674 [PubMed - ind

ECPR in OHCA and IHCA (Belgium)

Time from C.arrest to ECMO flow determine outcome

IHCA survived (with good neurologic outcome) 40-50 %

< 30 min	survival 50 %
30 – 60 min	survival 30 %
> 60 min	survival 18%

OHCA survival rate 15-20 % provided that Time from arrest to ECMO < 60 min

Fagnoul D. Curr Opin Crit Care. 2014 Jun;20(3):259-65)

Resuscitation. 2014 Sep;85(9):1219-24. doi: 10.1016/j.resuscitation.2014.06.022. Epub 2014 Jun 30.

Improved outcome of extracorporeal cardiopulmonary resuscitation for out-of-hospital cardiac arrest--a comparison with that for extracorporeal rescue for in-hospital cardiac arrest.

Wang CH[1], Chou NK[2], Becker LB[3], Lin JW[4], Yu HY[5], Chi NH[2], Hunag SC[2], Ko WJ[2], Wang SS[2], Tseng LJ[2], Lin MH[5], Wu IH[2], Ma MH[6], Chen YS[7].

Author information

[1]Department of Cardiovascular Surgery, National Taiwan University Hospital, Taipei, Taiwan; Center for Resuscitation Science, Department of Emergency Medicine, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA 19104, USA; Department of Surgery, National Taiwan University Hospital, Hsin-Chu Branch, Hsinchu, Taiwan.
[2]Department of Cardiovascular Surgery, National Taiwan University Hospital, Taipei, Taiwan.
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[4]Depar
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[6]Depar
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ECPR in OHCA and IHCA (Taiwan, n=230)

	IHCA	OHCA	p
n	199	31	
Duration of ischemia	44.4±24.7 min	67.5±30.6 min	<0.05
Duration of ECMO	94±122 hr	61±48 hr	<0.05
Intervention post ECMO	50 %	50 %	
Survival to discharge	31.2 %	38.7 %	>0.05

Survival rate 33 % in both gr if duration of ischemia < 75 min

Wang CH. Resuscitation. 2014 Sep;85(9):1219-24

KEYWORDS: Cardiopulmonary resuscitation; Extracorporeal membrane oxygenation; In-hospital cardiac arrest; Out-of-hospital cardiac arrest

PMID: 24992872 [PubMed - indexed for MEDLINE]

Crit Care. 2014 Sep 26;18(5):535. doi: 10.1186/s13054-014-0535-8.

An optimal transition time to extracorporeal cardiopulmonary resuscitation for predicting good neurological outcome in patients with out-of-hospital cardiac arrest: a propensity-matched study.

Kim SJ, Jung JS, Park JH, Park JS, Hong YS, Lee SW.

Abstract

INTRODUCTION: Prolonged conventional cardiopulmonary resuscitation (CCPR) is associated with a poor prognosis in out-of-hospital cardiac arrest (OHCA) patients. Alternative methods can be needed to improve the outcome in patients with prolonged CCPR and extracorporeal cardiopulmonary resuscitation (ECPR) can be considered as an alternative method. The objectives of this study were to estimate the optimal duration of CPR to consider ECPR as an alternative resuscitation method in patients with CCPR, and to find the indications for predicting good neurologic outcome in OHCA patients who received ECPR.

METHODS:
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RESULTS:
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CPR duratio
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and therape

CONCLUSI
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implantation
improve the

PMID: 252558

ECPR in OHCA (Korea)

Estimate the optimal duration of CPR to consider ECPR
Predictors for good neurological outcome after ECPR
Compare conventional CPR (444) with OHCA-ECPR (55)

1. Predicted duration for favorable neuro outcome (CPC1,2) is < 21 min CPR
2. **More favorable neuro outcome in ECPR vs CCPR at 3 month**

Predictor for good neurological outcomes

- young age
- witnessed arrest without initial asystole
- early achievement of mean BP ≥ 60 mmHg
- therapeutic hypothermia
- low ECPR-related complications

Kim SJ. Crit Care. 2014 Sep 26;18(5):535

RESUSCITATION

OFFICIAL JOURNAL OF THE EUROPEAN RESUSCITATION COUNCIL

European Resuscitation Council

Refractory cardiac arrest treated with mechanical CPR, hypothermia, ECMO and early reperfusion (the CHEER trial)☆

Dion Stub, Stephen Bernard, Vincent Pellegrino, Karen Smith, Tony Walker, Jayne Sheldrake, Lisen Hockings, James Shaw, Stephen J. Duffy, Aidan Burrell, Peter Cameron, De Villiers Smit, David M. Kaye

DOI: http://dx.doi.org/10.1016/j.resuscitation.2014.09.010 | CrossMark

Article Info

Publication History

Published Online: September 30, 2014
Accepted: September 11, 2014
Received in revised form: August 22, 2014
Received: November 20, 2013

CHEER trial (single center, prospective)

Mechanical CPR + Hypothermia (33C) + VA ECMO + Early reperfusion

n = 26
OHCA = 11
IHCA = 15

ECMO 24/26 (92%)

Age	38 – 60 Y	median 52 Y
Time to ECMO	40 – 85 min	median 56 min
Intervention		
PCI	11/26 (42%)	
P.embolectomy	1/26 (4%)	
Return of spontaneous circulation	25/26	96%
Duration of ECMO support	1 – 5 days	median 2 days
Successfully weaned ECMO	13/24	54%
Survival to hospital discharge with full neurological recovery	14/2	54%

Stub D. Resuscitation 2015 Jan;86:88-94.

Indications : In-Hospital Cardiac Arrest (IHCA)

- Acute coronary syndrome AND
  likely to be reversible with cath lab treatment
- Cardiac arrest in cath lab
- Suspected massive pulmonary embolism
- Any reversibility cause

Indications : Out-of-Hospital Cardiac Arrest (OHCA)

- *Suspected cardiac origin*

  Age < 60 years

  No flow < 10 min

  Initial rhythm VT/VF

  CPR >30min w/o ROSC

- Hypothermia <32C due to accidental exposure
- Drug overdose (vasoactive ie. Beta clocker, digoxin)
- Any reversibility of cardiac arrest

Exclusions

- Poor neurological recovery after CPR
  - Non witnessed OHCA
  - Initial cardiac rhythm was not VF
  - No provided neurological protection (hypothermia)
- Poor / non recovery underlying cardiac condition
- Limited of medical treatment that precludes further resuscitation
- Advanced age

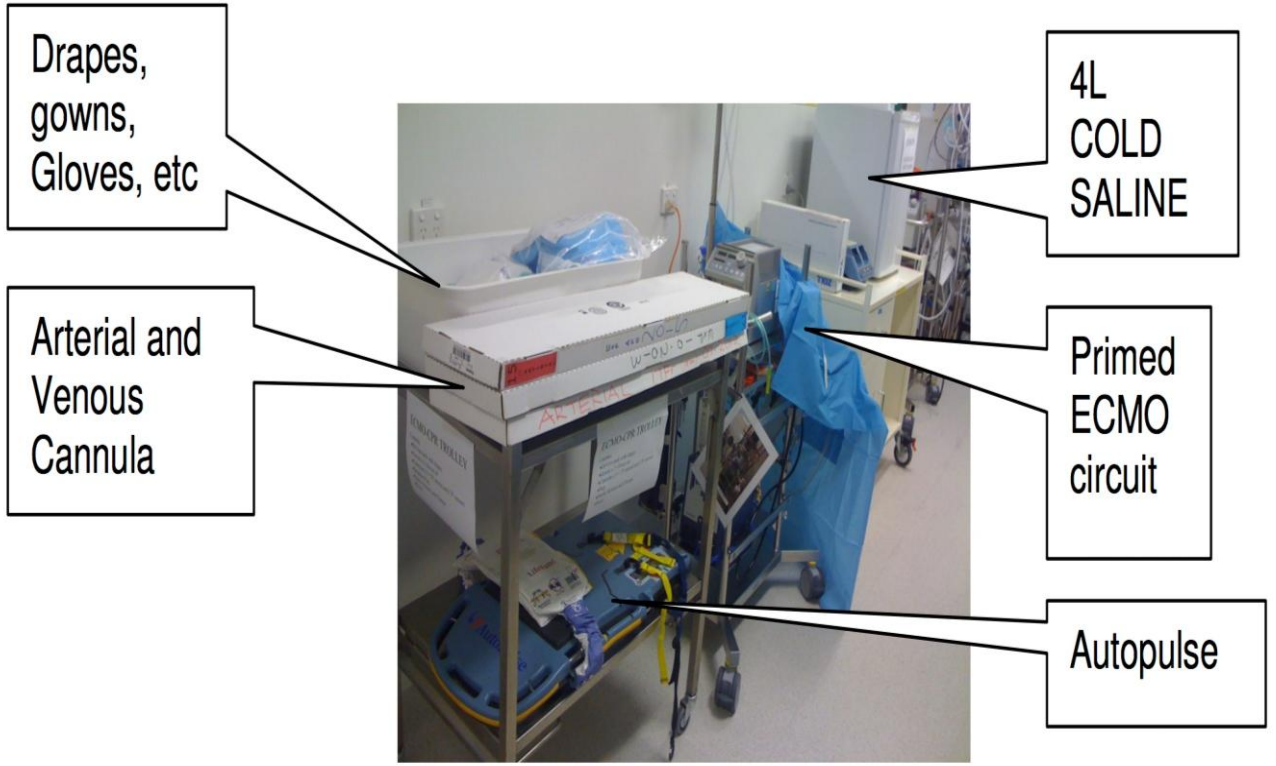
Cannula Size

- Assess vessel size when first identified
- Vein will often disappear with handling
- Size arterial cannula first
- Don’t go too big

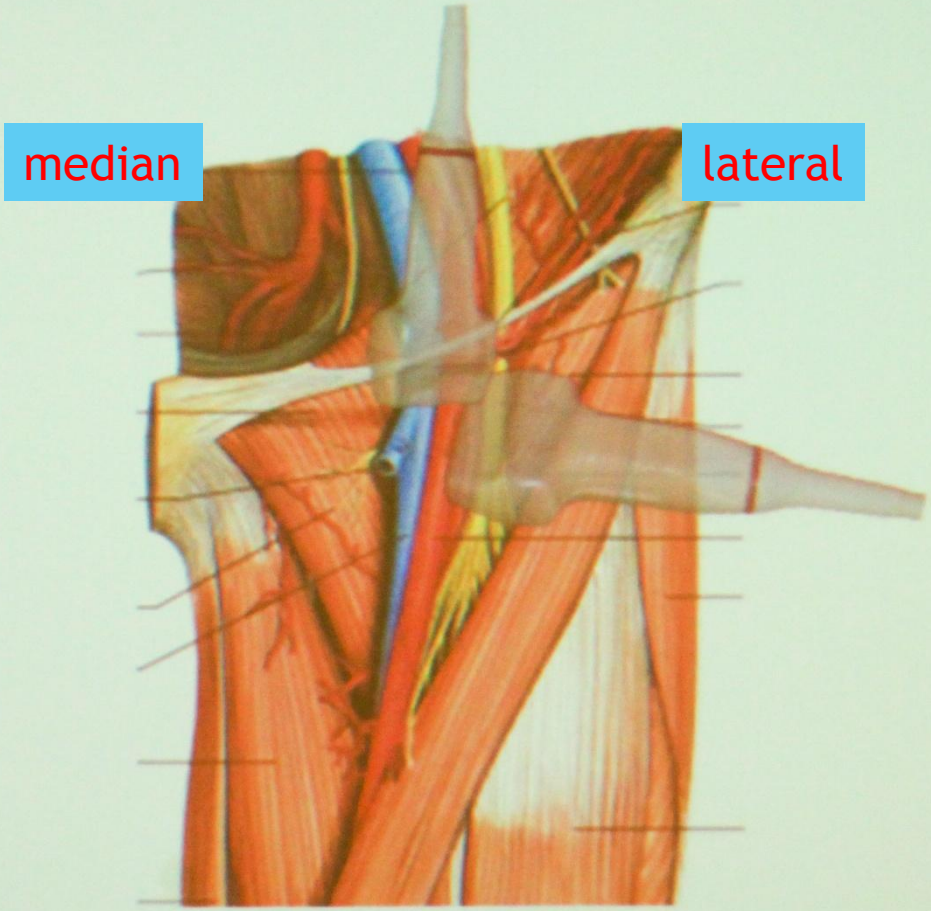
Equipment

ECMO-CPR trolley

- Sterile drapes, instruments, gowns, gloves, Betadine, clamps
- 15F and 17F arterial cannulae
- 17F venous cannula
- Autopulse machine



Precannulation Assessment- Femoral Vessels



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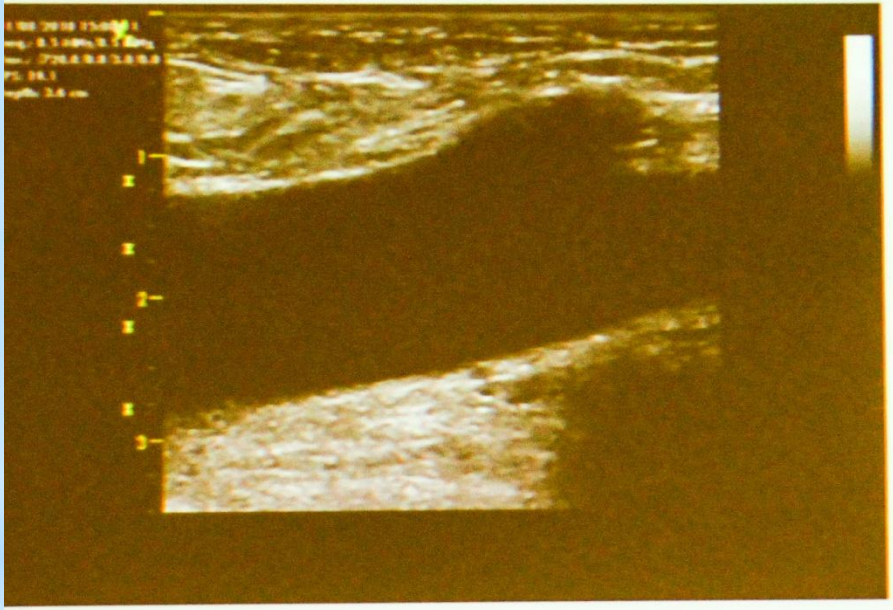
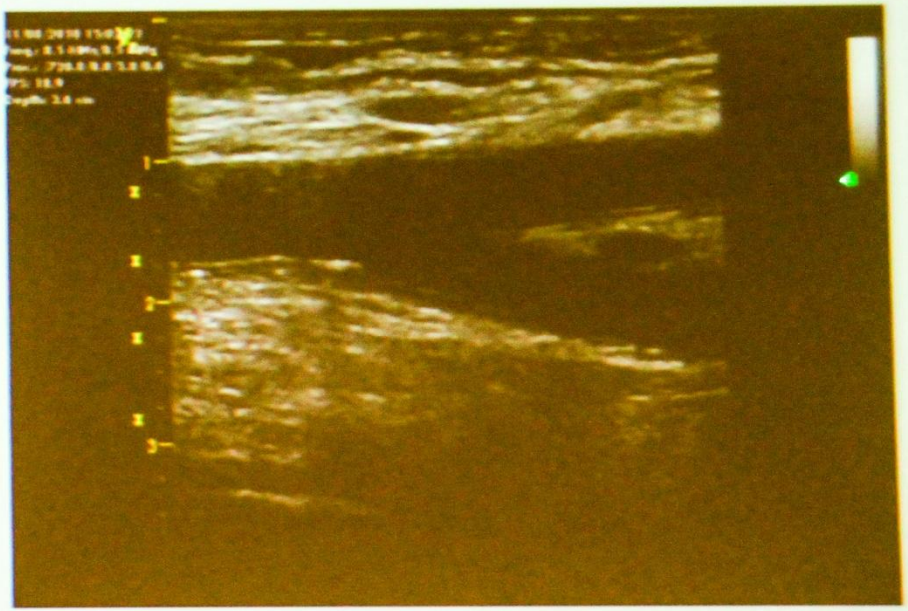


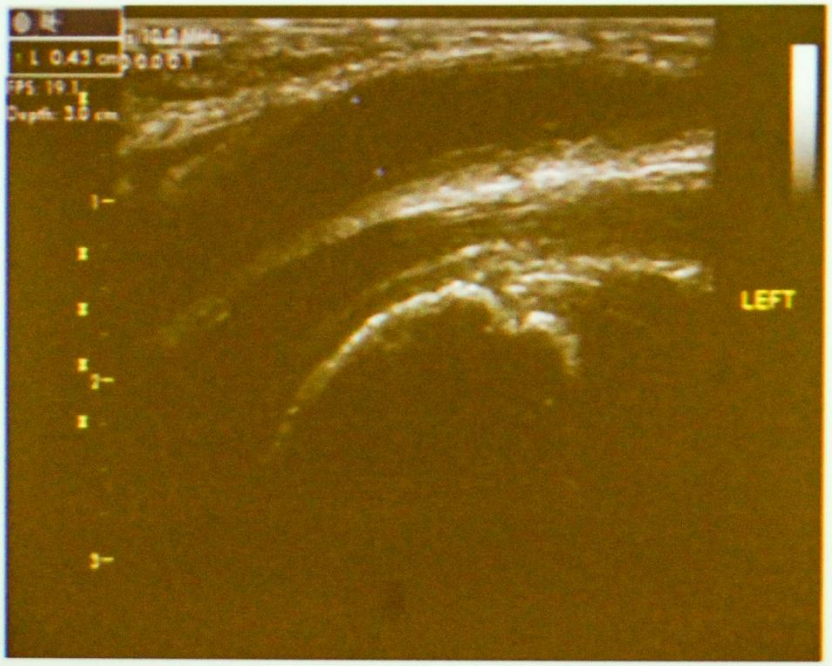
Long saphenous vein draining into Common Femoral Vein



Common Femoral artery dividing into Superficial Femoral artery and deep femoral artery

Precannulation Assessment

- Measure the diameter of the vessels in mm
- Multiply by a factor of 3 to get the size of the cannula in French.



Left CFA diameter = 4.3 mm
Cannula size = 3 X 4.3 mm
= 13 Fr

Commencement of ECMO-CPR

- Ultrasound guided femoral vessels

- Venous guide wire must be imaged in the IVC
- Arterial guide wire must NOT be in the IVC

- Required skin incision for dilatation

- Smaller ECMO cannulae (15F arterial, 17F venous)
- Low ECMO flows (3-4L/min) during hypothermic arrest

- No femoral artery back-flow cannula at initial

- Hypothermia (32-34 C) is imperative

Maintenance

- Cardiac cause, transfer to cath lab
- Massive pulmonary embolism, thrombolysis / embolectomy
- Head injury, CT brain and C-spine
- Sedation and musle relaxant
- Leg ischemia, femoral artery back-flow cannula
- Hyperoxia (pO_2>300mmHg) may be harmful during brain reperfusion
- Monitor bladder and nasopharyngeal Temp

Maintenance

Hypothermia

- hypothermia (33C) for 24 hr post cardiac arrest
- Rewarm no faster than 3C over 12 hr (0.25C per hr)
- Shivering (often at 34-35.5C) treat with muscle relaxant
- Hypotension treat with fluid challenge, vasopressor
- Cessation of rewarming if hypotension untreated

Respiratory

- Ventilator setting when cardiac function returns
- Target pO2 70-90mmHg, pCO2 40mmHg
- Use TV 6ml/kg, RR 8/min initial setting

Cardiac

- SBP >100mmHg, accept HR 35-50/min without treatment
- If need higher ECMO flow, consider second venous cannula

Maintenance

- Monitor electrolytes (K+, Mg++, PO4-)
- Avoid Calcium infusion in neurologic injury
- Hyperglycemia required insulin infusion
- Heparinize, ACT 180-220, APTT 50-70
- Sedation, midazolam if unstable BP

Prognostication

- Assessment of neurological recovery at 96hr (>48 hr after cessation of sedation)

AHA Guidelines. Circulation 2015;132:S436-443

Part 6: Alternative Techniques and Ancillary Devices for Cardiopulmonary Resuscitation

2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

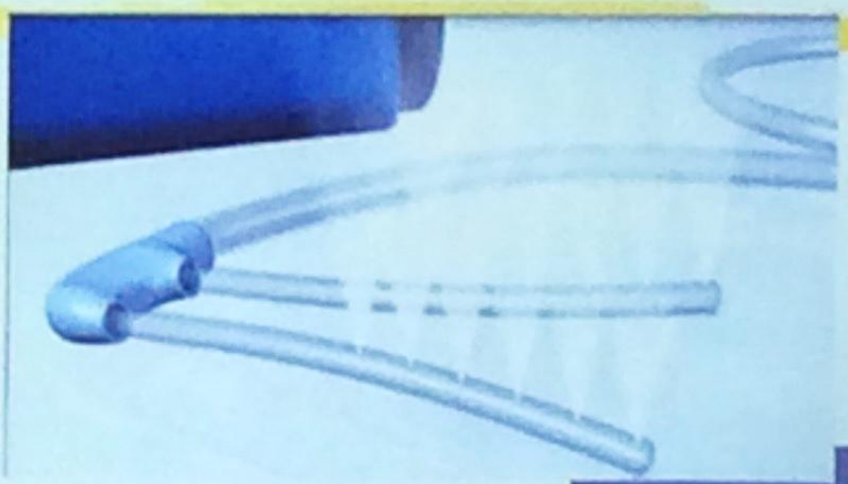
2015 Recommendation—New

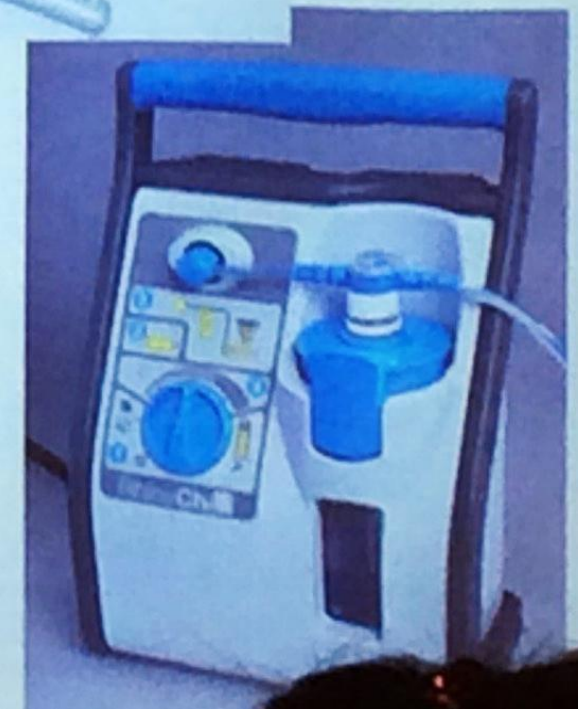
There is insufficient evidence to recommend the routine use of ECPR for patients with cardiac arrest. In settings where it can be rapidly implemented, ECPR may be considered for select patients for whom the suspected etiology of the cardiac arrest is potentially reversible during a limited period of mechanical cardiorespiratory support (Class IIb, LOE C-LD). Published

Early cooling easy to accomplish

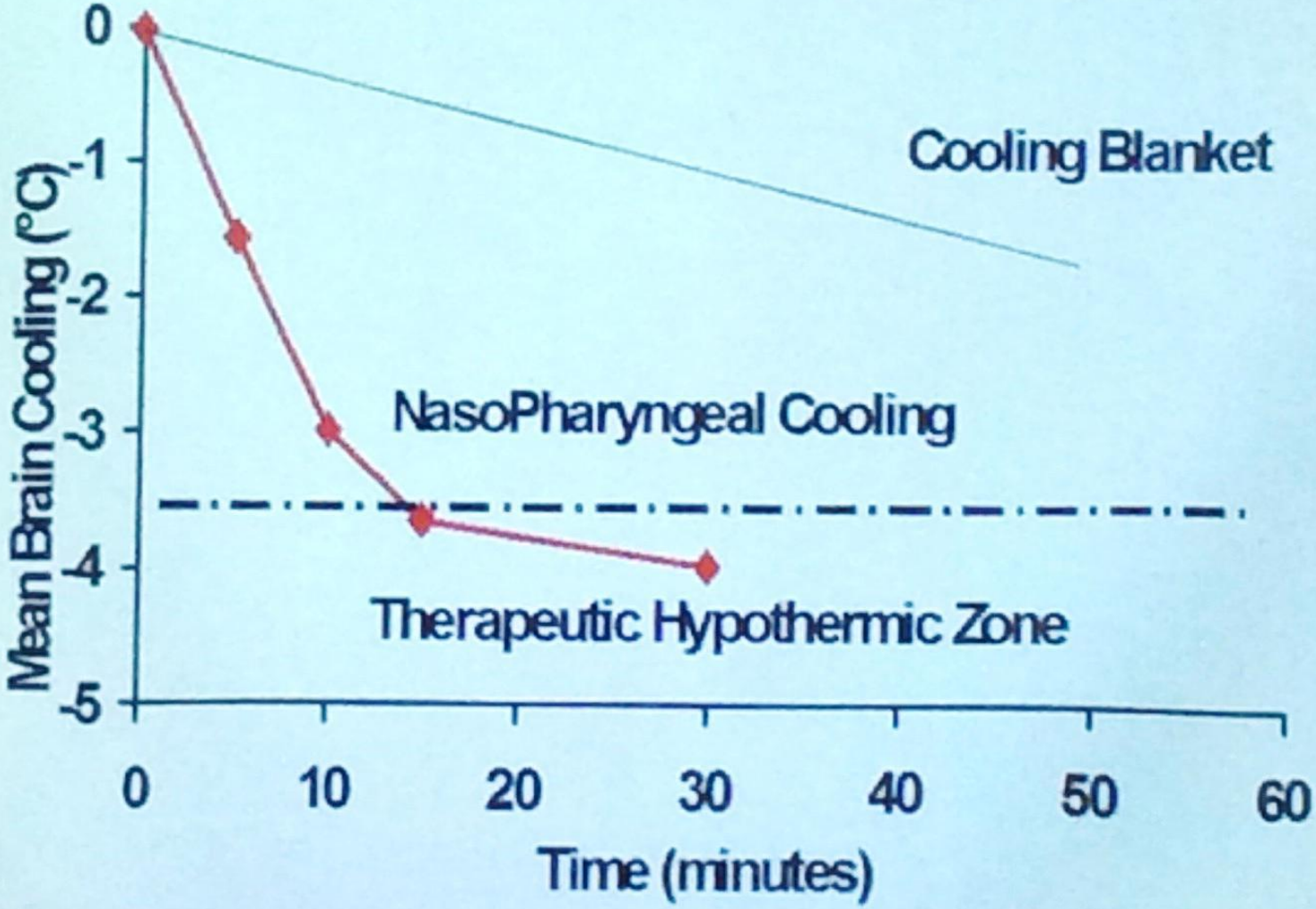
RhinoChill is:

- Non-invasive
- Portable
- Technically simple
- No refrigeration
- Battery operated





Comparison of Brain Cooling Rates



Wolfson et al. NeuroCrit Care 8(3):437-47, 2008.

ECPR studies in OHCA

Author	Year of publication	N	Time to ECMO (min)	Survival
Nagao	2000	36	67	25 %
Haneya	2012	26	70	15 %
Kagawa	2012	42	59	24 %
Nagao	2010	171	66	12 %
Le Guen	2011	51	120	4%
Avalli	2012	18	77	6 %
Fagnoul	2013	53	66	21 %
Maekawa	2013	53	49	32 %
Leick	2013	28	44	39 %
SAVE-J Sakamoto	2014	260	-	12 %
CHEER	*2014*	11	Impl. 20	27%
Choi	2016	320	54	9%

Extracorporeal Life Support Organization (ELSO)

Guidelines for ECPR Cases

Introduction

This ECPR guideline is a supplement to ELSO's "General Guidelines for all ECLS Cases" which describes prolonged extracorporeal life support (ECLS, ECMO). This supplement addresses specific discussion for ECPR cases.

This guideline describes prolonged extracorporeal life support (ECLS, ECMO). This guideline describes useful and safe practice, but these are not necessarily consensus recommendations. These guidelines are not intended as a standard of care, and are revised at regular intervals as new information, devices, medications, and techniques become available.

ELSO guidelines for ECPR (2013)

Patients selection

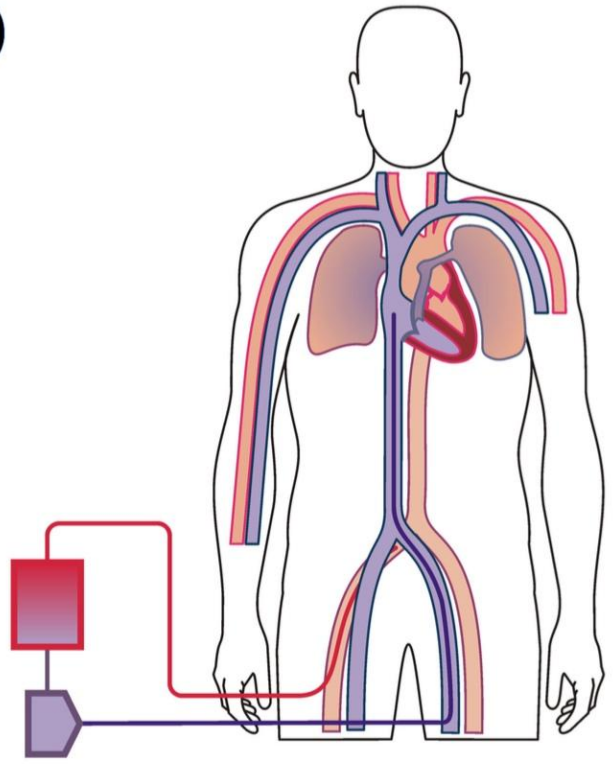
- Easily reversible event
- Return of spontaneous circulation in 5-30min
- Good perfusion and metabolic support documented

Vascular access

- Central (recent sternotomy)
- Peripheral
  - prefer open
  - percutaneous
    - BW > 15 Kg
    - Vascular access exists prior to CPR

Emergency VA ECMO

- Access:
  - Multistage (19-21F)
- Return
  - Single stage (15-17F)



ELSO guidelines for ECPR (2013)

Management

- Rapid cannulation
- CNS protection during and after CPR
  - Total body hypothermia for 48-72 hr after ECMO
  - Neurological exams after stable
- Evaluation of LA hypertension, decompression if indicated
- Diagnostic procedures if stable ECMO flows (ECHO, cardiac cath, imaging)

Weaning

- Institution's ECMO guidelines
- Long-term follow-up neurology / development pediatrics

ECLS Registry Report

International Summary

July, 2016

Extracorporeal Life Support Organization
2800 Plymouth Road
Building 300, Room 303
Ann Arbor, MI 48109

Overall Outcomes

	Total Patients	Survived ECLS		Survived to DC	
Neonatal					
Respiratory	29,153	24,488	84%	21,545	74%
Cardiac	6,475	4,028	62%	2,695	42%
ECPR	1,336	859	64%	547	41%
Pediatric					
Respiratory	7,552	5,036	67%	4,371	58%
Cardiac	8,374	5,594	67%	4,265	51%
ECPR	2,996	1,645	55%	1,232	41%
Adult					
Respiratory	10,601	6,997	66%	6,121	58%
Cardiac	9,025	5,082	56%	3,721	41%
ECPR	2,885	1,137	40 %	848	30 %
Total	78,397	54,866	70%	45,345	58%