Extra-Corporeal Membrane Oxygenation During Cardio-Pulmonary Resuscitation ECPR

April 22, 2016

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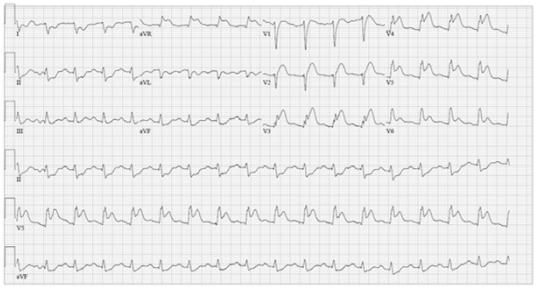
Disclosures

- Nothing to disclose.

Case

- History
  - 60 y/o male
  - No prior history of CAD
  - In car at casino complaining of chest pain
  - Depression, Smoker
  - FH: Father PE, mother renal transplant, brother hyperlipidemia
- Exam
  - Pale, diaphoretic, confused
  - SBP=100, cool extremities

ECG



Case

- ED course
  - Progressively obtunded
  - Level 1 activated
  - Ticagrelor 180mg, heparin 4000U, ASA
  - Multiple episodes of ventricular tachycardia
  - Multiple defibrillation, CPR
  - Progressive shock, Intubated
  - External cooling, Lucas, transfer to ANW
  - Labs: pH: 6.8 pO2: 54 pCO2: 58.5 bicarbonate: 9.8, lactate 10.5

Case Summary

- Acute STEMI
- VT/VF arrest
- Cardiogenic shock
- Recurrent cardiac arrest and refractory shock
  - LUCAS dependent upon arrival (110 minutes)

Next Steps

- Is this patient dead?
- Basic Life Support (BLS)
- Advanced Cardiopulmonary Life Support (ACLS)

Next Steps

- Is this patient dead?
- Basic Life Support (BLS)
- Advanced Cardiopulmonary Life Support (ACLS)
- ECMO Cardiopulmonary Life Support (ECLS)

ECPR

- Definition
- Purpose
- Evidence
- Indications
- Methods
- Outcomes

ECPR Definition

The utilization of extra-corporeal membrane oxygenation via femoral venous and arterial access to provide artificial cardiopulmonary circulation as an alternative to traditional ventilation and external cardiac massage

ECPR Purpose

- Improve
  - Outcomes
- Extension
  - Beyond BLS and ACLS for refractory cardiac arrest
- Reversal
  - Management of post resuscitation syndrome
- Bridge
  - Interventional therapies to allow management of potential reversible conditions

ECPR Purpose

- Improving Cardiac Arrest Outcomes
  - 1950's mortality 50%
    - Stephenson HE Jr. *Ann Surg.* 1953; 137: 731–744
  - 1966 original consensus statement on CPR
    - National Academy of Sciences–National Research Council Ad Hoc Committee on Cardiopulmonary Resuscitation. Cardiopulmonary resuscitation. *JAMA.* 1966; 198: 372–379
  - Currently overall prognosis after ROSC has only minimally improved

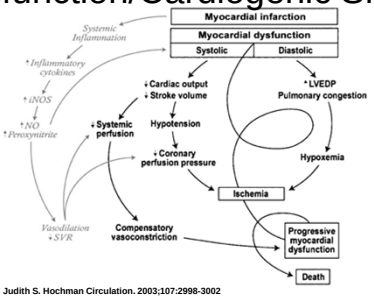
ECPR Purpose

- Research focused on improving the rate of ROSC
- Post Resuscitation Syndrome
  - Brain injury
  - Myocardial Dysfunction/Cardiogenic Shock
  - Systemic Ischemia/Reperfusion Response
  - Persistent Precipitating Pathology

Systemic Ischemia/Reperfusion Response

- Most severe state of cardiogenic shock
  - Abrupt cessation of oxygen and nutrient delivery
  - Increased oxygen debt
  - Endothelial activation and inflammatory response
  - Multisystem organ failure
- Whole body ischemia/reperfusion
  - Activation of immunological and coagulation pathways
  - Multisystem organ failure

Myocardial Dysfunction/Cardiogenic Shock



Judith S. Hochman Circulation. 2003;107:2998-3002

American Heart Association.

ECPR Purpose

- Potential role for ECMO
  - Extend resuscitation when ROSC cannot be achieved
  - Reverse the consequences of post resuscitation syndrome
  - Increase likelihood of achieving ROSB
  - Allow evaluation and intervention on underlying etiology of cardiac arrest

ECPR Evidence

- No prospective randomized clinical trials
- ESLO ECLS Registry
- Several small observational studies

ECPR Evidence

ECLS Registry Report
International Summary
January, 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 or Transfer	
Neonatal					
Respiratory	28,723	24,155	84%	21,274	74%
Cardiac	6,269	3,885	62%	2,599	41%
ECPR	1,254	806	64%	514	41%
Pediatric					
Respiratory	7,210	4,787	66%	4,155	58%
Cardiac	8,021	5,341	67%	4,067	51%
ECPR	2,788	1,532	55%	1,144	41%
Adult					
Respiratory	9,102	5,989	66%	5,254	58%
Cardiac	7,850	4,394	56%	3,233	41%
ECPR	2,379	948	40%	707	30%
Total	73,596	51,837	70%	42,947	58%

ECPR Evidence

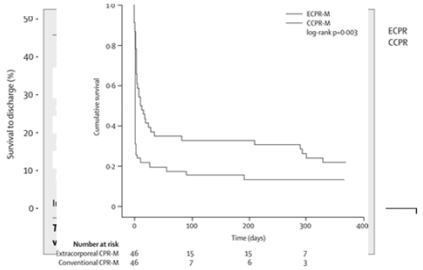
Table 4
Logistic regression analysis of factors associated with good neurological function at discharge.

Variable	Odds ratio	95% CI
Age (years)	1.0621	0.9757–1.1561
CPR duration (min)	0.9695	0.9194–1.0223
Use of ECMO	25.4382	2.6795–241.4981
Defibrillation (times)	0.9907	0.7366–1.3325
Female gender	1.2560	0.1190–13.2589
Use of therapeutic hypothermia	1.1057	0.1870–6.5362

Results are odds ratios and 95% confidence intervals. ECMO, extracorporeal membrane oxygenation.

Resuscitation 2015 92, 70-76DOI: (10.1016/j.resuscitation.2015.04.016)

ECPR Evidence



The Lancet 2008 372, 554-561DOI: (10.1016/S0140-6736(08)60958-7)

Contents lists available at ScienceDirect
Resuscitation
journal homepage: www.elsevier.com/locate/resuscitation

Clinical Paper

Extracorporeal cardiopulmonary resuscitation versus conventional cardiopulmonary resuscitation in adults with out-of-hospital cardiac arrest: A prospective observational study☆

Tetsuya Sakamoto, Naoto Morimura*, Ken Nagao, Yasufumi Asai, Hiroyuki Yokota, Satoshi Nara, Mamoru Hase, Yoshio Tahara, Takahiro Atsumi, SAVE-J Study Group[1]

The Japanese Scientific Research Group of the Ministry of Health, Labour and Welfare for Extracorporeal Cardiopulmonary Resuscitation: Study of Advanced Cardiac Life Support for Ventricular Fibrillation with Extracorporeal Circulation in Japan (SAVE-J), Japan

- Prospective observational study
- OHCA Cardiac arrest VT/VF
- Arrival within 45 minutes
- 454 patients (260 ECPR, 194 CPR)
- Favorable neurological outcomes (CPC 1-2) ITT
  - One month 12.3% ECPR and 1.5% CPR (p<0.0001)
  - Six month 11.2% ECPR and 2.6% CPR (p,0.001)

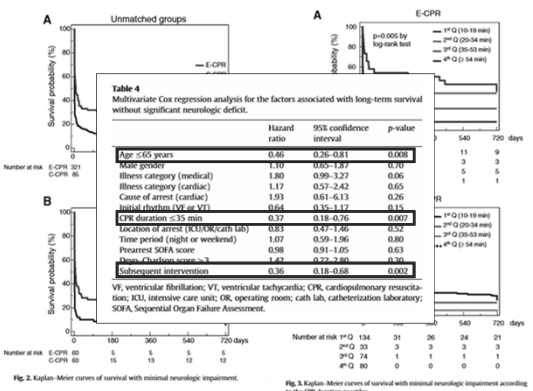


Fig. 2. Kaplan–Meier curves of survival with minimal neurologic impairment.

Table 4
Multivariate Cox regression analysis for the factors associated with long-term survival without significant neurologic deficit.

	Hazard ratio	95% confidence interval	*p*-value
Age ≤65 years	0.46	0.26–0.81	0.008
Male gender	1.10	0.65–1.87	0.70
Illness category (medical)	1.80	0.99–3.27	0.06
Illness category (cardiac)	1.17	0.57–2.42	0.65
Cause of arrest (cardiac)	1.93	0.61–6.13	0.26
Initial rhythm (VF or VT)	0.64	0.35–1.17	0.15
CPR duration ≤35 min	0.37	0.18–0.76	0.007
Location of arrest (ICU/OR/cath lab)	0.81	0.47–1.66	0.52
Time period (night or weekend)	1.07	0.59–1.96	0.80
Prearrest SOFA score	0.98	0.91–1.05	0.63
Deyo–Charlson score >3	1.42	0.72–2.80	0.30
Subsequent intervention	0.36	0.18–0.68	0.002

VF, ventricular fibrillation; VT, ventricular tachycardia; CPR, cardiopulmonary resuscitation; ICU, intensive care unit; OR, operating room; cath lab, catheterization laboratory; SOFA, Sequential Organ Failure Assessment.

Fig. 3. Kaplan–Meier curves of survival with minimal neurologic impairment according to the CPR duration quartiles.

Resuscitation
Volume 86, January 2015, Pages 88–94

Clinical Paper

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

Dion Stub[b, f, g], Stephen Bernard[a, b, d], ⁂, ✉, Vincent Pellegrino[a], Karen Smith[b, d, e], Tony Walker[a], Jayne Sheldrake[a], Lisen Hockings[a], James Shaw[a, b, c], Stephen J. Duffy[a, b, c], Aidan Burrell[a, b], Peter Cameron[a, b], De Villiers Smit[a], David M. Kaye[a, b, c]

- Prospective study
- Age 18-65 years
- Cardiac arrest of cardiac origin
- Initial rhythm VF
- CPR>30min
- 26 patients, 11 OHCA, 15 IHCA
- Mechanical chest compression
- Hypothermia
- EMS activated, ED ECMO
- Wean from ECMO 54%
- Hospital discharge 54%
- CPC 1 survivors 100%

ECPR Evidence


Contents lists available at SciVerse ScienceDirect

Resuscitation

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

Clinical paper

Emergency physician-initiated extracorporeal cardiopulmonary resuscitation☆

Joseph M. Bellezzo[a,*], Zack Shinar[a,b], Daniel P. Davis[c], Brian E. Jaski[b], Suzanne Chillcott[b], Marcia Stahovich[b], Christopher Walker[b], Sam Baradarian[b], Walter Dembitsky[b]

[a] Sharp Memorial Hospital, Emergency Department, 7901 Frost Street, San Diego, CA 92123, United States
[b] Sharp Memorial Hospital, 7901 Frost Street, San Diego, CA 92123, United States
[c] University of California, San Diego, Emergency Medicine, 200 West Arbor Drive #8676, San Diego, CA 92103-8676, United States

- 42 patients in cardiac arrest
- 18 patients met protocol criteria of ECPR
- 8 resuscitated on ECMO/ECPR
- 5 discharged neurologically intact (61%)

ECPR Indications

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

Part 6: Alternative Techniques and Ancillary Devices for Cardiopulmonary Resuscitation

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

Steven C. Brooks, Chair; Monique L. Anderson; Eric Bruder; Mohamud R. Daya; Alan Gaffney; Charles W. Otto; Adam J. Singer; Ravi R. Thiagarajan; Andrew H. Travers

ECPR Indications

2015	Extracorporeal Techniques and Invasive Perfusion Devices: Extracorporeal CPR	There is insufficient evidence to recommend the routine use of ECPR for patients with cardiac arrest. It 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).	new for 2015

ECPR Indications

- Similar indications as for BLS/ACLS
  - Patient generally healthy prior to cardiac arrest
  - Goals of therapy are curative
  - Cause of cardiac arrest treatable
- When traditional BLS/ACLS strategies have failed
  - Extension of traditional BLS/ACLS
- In hospital vs out of hospital

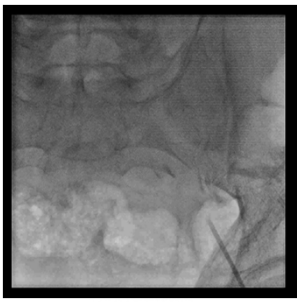
ECPR Indications

- ANW in hospital ECPR protocol
  - Age 18-75
  - Arrest of cardiac origin (VT/VF)
  - ETCO2>20
  - Patient on HH4000/5000/5200 or CVICU
  - ECPR candidacy determined at 10 minutes
  - LEVEL 1 ECMO called and patient transferred to cath lab on LUCAS
  - ECMO initiation within 60 minutes of arrest

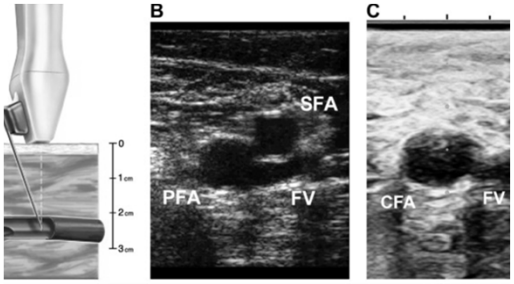
ECPR Indications

- ANW out of hospital ECPR protocol
  - Age 18-75
  - Witnessed arrest of cardiac origin (VT/VF)
  - No flow of less 5 minutes
  - ETCO2>10
  - Consistent MAP during transport (MAP 45mmHg or SBP 70mmHg)
  - LEVEL-1 ECMO activation of the Cath lab
  - ECMO initiation within 60 minutes of arrest

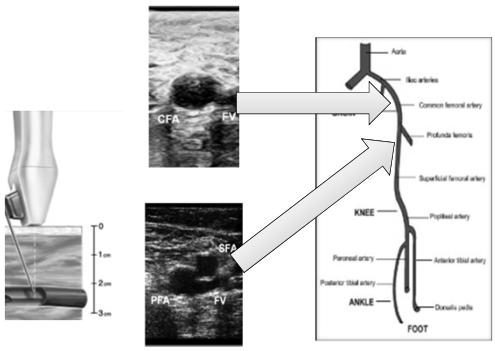
ECPR Method



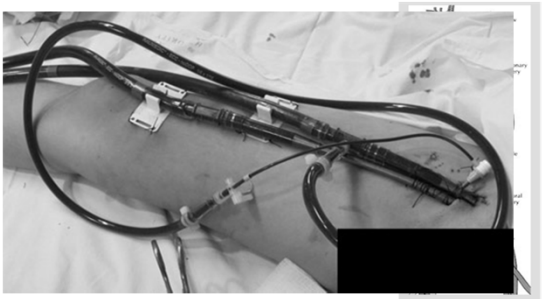
Vascular Ultrasound

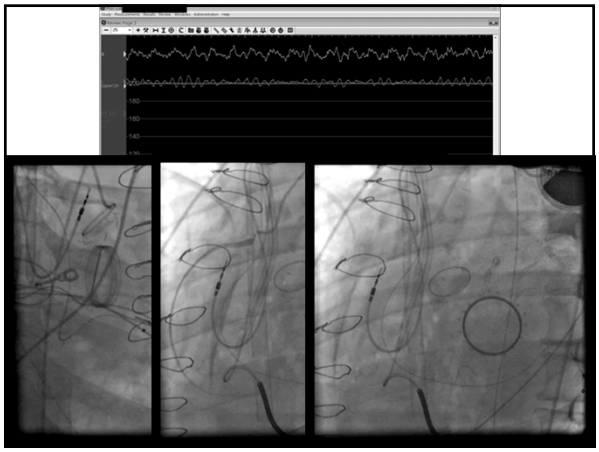


J Am Coll Cardiol Intv. 2010;3(7):751-758. doi:10.1016/j.jcin.2010.04.015



ECMO Cannulation





ECPR: Method

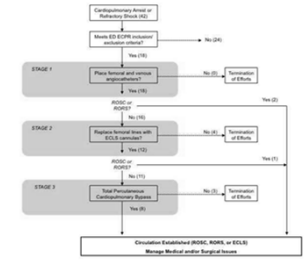
Table 1
Inclusion/exclusion criteria.

Inclusion criteria:
Persistent cardiopulmonary arrest despite traditional resuscitative efforts
Shock (SBP < 70 mmHg) refractory to standard therapies
Exclusion criteria:
Initial rhythm asystole
Chest compressions not initiated within 10 min of arrest (either bystanders or EMS personnel)
Estimated EMS transport time >10 min
Total arrest time >60 min
Suspicion of shock due to sepsis or hemorrhage
Pre-existing severe neurological disease prior to arrest (including traumatic brain injury, stroke, or severe dementia)

SBP, systolic blood pressure; EMS, emergency medical services.

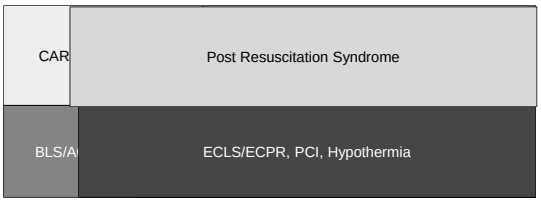
J.M. Bellezzo et al. / Resuscitation *83 (2012) 966–970*

ECPR: Methods



J.M. Bellezzo et al. / Resuscitation *83 (2012) 966–970*

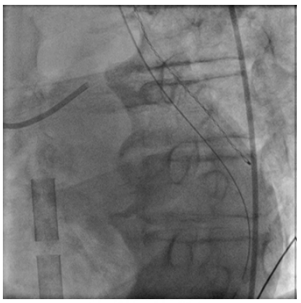
ECPR Paradigm Shift



Improve Survival

Improve Survival

Coronary Angiogram



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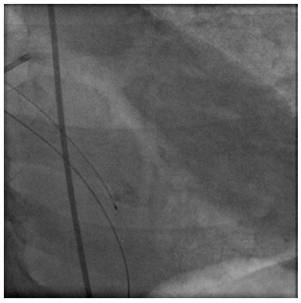

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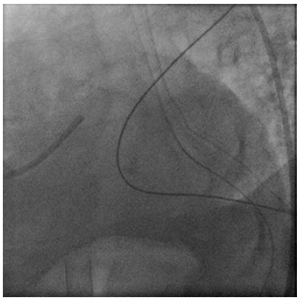

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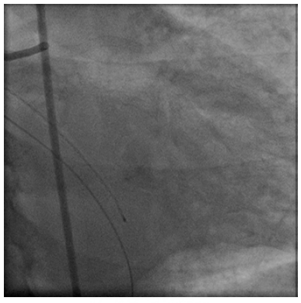

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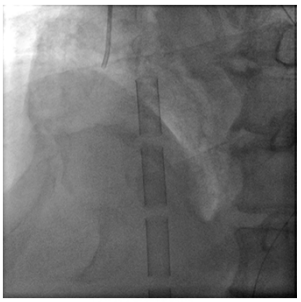

Summary

- Improving survival following cardiac arrest continues to be challenging
- ECPR can provide an extension to traditional ACLS for refractory cardiac arrest
- ECPR facilitates the management of post resuscitation syndrome and it's consequences
- ECPR facilitates ROSC/ROSB
- ECPR improve both short term and long term outcomes compared to conventional CPR

Summary

- ECPR is associated with improved neurological outcomes compared conventional CPR
- Shortening time of CPR with ECPR (<35 min) is associated with better outcomes
- Cannulation can be challenging
- ECPR provides a bridge to definitive therapy
- ECPR indications are similar to those for BLS/ACLS
- Patient selection important

*"It just so happens that your friend here is only **MOSTLY dead**. There's a big difference between **mostly dead** and all **dead**. **Mostly dead** is slightly alive!"*

-Billy Crystal as Miracle Max The Princess Bride 1987

Case