Extracorporeal Cardiopulmonary Resuscitation (ECPR) for Cardiac Arrest

A review of the evidence

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Faculty/Presenter Disclosure

• Faculty: Steven Brooks

• Relationships with commercial interests:
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  – Speakers Bureau/Honoraria: None
  – Consulting Fees: None
  – Other: None
Disclosure of Commercial Support

• This program has received no financial support from any commercial organization

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  – None
Objectives

• ECPR, E-CPR, ECLS, ECMO — what are we talking about?
• The rationale for ECPR — why bother?
• The evidence
• The future
The False Prophet

• This will **not** be a how-to talk
• For that, you need to speak to these guys:

  • edecmo.org
What are we talking about?

- ECMO or ECLS
  - Establishing cardiopulmonary bypass using mechanical circulatory support systems
What are we talking about?

- ECPR
  - Initiation of bypass during cardiac arrest
ECPR: The Basics

VA-ECMO

- Femoral Artery
- Returning Oxygenated Blood
- De-oxygenated
ECPR: The setup
ECPR: The Basics
ECPR: The Basics
Why ECPR?

- Failed conventional ACLS
  - CCPR ~25% normal CO
- Pre-morbid status good
- Reversible cause
  - A bridge to definitive treatment
Who?

- Young post partum woman with suspected PE
- The patient with intermittent ROSC and STEMI
- The young man with verapamil overdose
The evidence
In-hospital cardiac arrest
Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis

- Chen et al. 2008
- Taipei
- N= 172
- Prospective observational study
  - Conventional CPR vs ECPR
- ECPR team on call
- Propensity-matching
Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis

• Included
  – Cardiac origin (adjudicated)
  – Age 18-75
  – CPR >10 minutes

• Excluded
  – Past brain damage
  – Terminal malignancy
  – DNR
• Decision to implement ECPR at discretion of attending MD
• Results
  – ECPR group highly selected
    • Younger
    • More men
    • Less renal disease
    • Less cancer
    • More pressors pre arrest
    • More daytime arrests
Results

- ECPR group had more
  - ROSC 93% vs 55%
  - Interventions 61% vs 12%
  - Survival with good neurological function
Propensity-matched

- Improved survival out to one year
- No difference in survival with good neurological function
Extracorporeal cardiopulmonary resuscitation in patients with inhospital cardiac arrest: A comparison with conventional cardiopulmonary resuscitation

- Shin et al. 2011
- Seoul, Korea
- N= 406 (85 ECPR, 321 CCPR)
- Witnessed in-hospital cardiac arrest with CPR >10 minutes
- Included some non-cardiac causes
- Aged 18-80
- No previous neuro injury, malignancy
- No TTM, no CPR quality measured
- Propensity-matched
Extracorporeal cardiopulmonary resuscitation in patients with inhospital cardiac arrest: A comparison with conventional cardiopulmonary resuscitation

\[ p = 0.013 \] by stratified log-rank test

Cumulative survival (%)

Days

Crit Care Med 2011 Vol. 39, No. 1
Out-of-hospital cardiac arrest
Extracorporeal Cardiopulmonary Resuscitation for Patients With Out-of-Hospital Cardiac Arrest of Cardiac Origin: A Propensity-Matched Study and Predictor Analysis*

• Maekawa et al. 2013
• Sapporo, Japan
• N=162 (53 ECPR, 109 CCPR)
• EMS with EMTs (no drugs)
• MD ambulance dispatched as well
• No bystander AED
Extracorporeal Cardiopulmonary Resuscitation for Patients With Out-of-Hospital Cardiac Arrest of Cardiac Origin: A Propensity-Matched Study and Predictor Analysis*

Figure 2. Kaplan-Meier plot of the neurologically intact survival curves in the matched extracorporeal cardiopulmonary resuscitation (ECPR) group and the matched conventional cardiopulmonary resuscitation (CCPR) group for three months.

- 29% vs 8% intact survival at 3 months
Sakamoto et al. 2014

Japan – 46 hospitals

N=454 (234 ECPR, 159 CCPR)

Prospective observational study

Hospitals self-selected to ECPR or CCPR

Intention-to-treat

Included: age 20-75, VF/VT, OHCA, <45 mins from 911 call to ER arrival, no ROSC 15 mins after ER arrival

Excluded: non cardiac cause, poor pre-morbid function, hypothermic <30 degrees Celsius
Results

Characteristics b/w groups similar

90% male

ECPR hospitals more TTM (91% versus 54%), more IABP (92% versus 62%)

Increased intact survival at 1 month with ECPR
- 12.3% versus 1.5%
Largest study to date but difficult to interpret

- Selection bias
- Differences in post resuscitation care
- ? CPR quality
Summary

• ECPR is feasible in these settings
• Observed benefit with ECPR over CCPR in highly selected patients
• Best available data has a very high risk of bias
  – Comparison groups dissimilar
  – Unmeasured confounders
• Time interval between arrest and going on pump is likely very important
Is an emergency department-based ECPR program feasible?
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

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c University of California, San Diego, Emergency Medicine, 200 West Arbor Drive #8576, San Diego, CA 92103-8676, United States

• Retrospective analysis
• Emerg docs putting patients on pump
  – Initial training and then q monthly
  – Critical care nurses to manage ECMO circuit until perfusionist
• 3 stage approach
  – Angiocaths in femoral vessels
  – Replacing angiocaths with ECLS catheters
  – Putting the patient on pump
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Table 1
Inclusion/exclusion criteria.

<table>
<thead>
<tr>
<th>Inclusion criteria:</th>
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<tbody>
<tr>
<td>Persistent cardiopulmonary arrest despite traditional resuscitative efforts</td>
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<tr>
<td>Shock (SBP &lt; 70 mmHg) refractory to standard therapies</td>
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<table>
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<tr>
<td>Initial rhythm asystole</td>
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<tr>
<td>Chest compressions not initiated within 10 min of arrest (either bystanders or EMS personnel)</td>
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<tr>
<td>Estimated EMS transport time &gt; 10 min</td>
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<tr>
<td>Total arrest time &gt; 60 min</td>
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<td>Suspicion of shock due to sepsis or hemorrhage</td>
</tr>
<tr>
<td>Pre-existing severe neurological disease prior to arrest (including traumatic brain injury, stroke, or severe dementia)</td>
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</tbody>
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SBP, systolic blood pressure; EMS, emergency medical services.
27% of those eligible for ECPR survived with good neurological function.

63% of those put on pump survived with good neurological function.

1 year
Take home points

- An ER-based ECPR program is feasible
- ER docs can be trained to put patients on pump but it isn’t easy
- Potential to salvage some highly selected cardiac arrest patients
The CHEER Trial

Clinical Paper

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

Dion Stub c,f,g, Stephen Bernard a,b,d,*, Vincent Pellegrino a, Karen Smith b,d,e, Tony Walker d, 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

- Case series
- Refractory OHCA and IHCA (>30 mins)
- Age 18-65
- Cardiac etiology
- VF
- <10 minutes to CPR
- IHCA – MD discretion
The CHEER Trial

45% Survival

60% Survival

CPC 1-2
The CHEER Trial

• Complications
  – 76% had a major complication
  – 1 failed cannulation
  – 69% required blood transfusion (median 3.5 units)
  – Vascular surgery in 42%
    • Femoral artery repair
    • Backflow catheter placement
    • Fasciotomy for ischemic limb
Knowledge Gaps

• We need controlled clinical trials to determine efficacy
• How?
  – Optimal flow rates?
• Who?
• What is the optimal target temperature for patients on ECPR after cardiac arrest?
• What are reliable prognostic factors for patients treated with ECPR after cardiac arrest?
On-going studies

• Prague OHCA study
  – “Hyper-invasive”
    • LUCAS, intra-arrest cooling, angio prior to ROSC, ECLS

• Vienna study
  – Pilot RCT
    • 15 minutes ACLS then transport and ECPR
Prehospital ECPR?
Prehospital ECPR?
Prehospital ECPR?
Prehospital ECPR?
Summary

• ECPR is feasible for patients with refractory cardiac arrest
  – ...but it’s not easy

• Best available data suggests a possible benefit over conventional CPR
  – ...in a highly select population with many potential uncontrolled confounders

• Data from ongoing RCTs will hopefully clarify the true effect
Thank you