Veno-Arterial ECMO for Refractory Cardiogenic Shock Patients

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VA-ECMO is now the first line device...

In the context of acute refractory cardiac failure
Extracorporeal Membrane Oxygenation: ECMO/ECLS

- ECMO = ExtraCorporeal Membrane Oxygenation:
  - Centrifugal Pump + Oxygenator: Heart-Lung support

- Peripheral vascular access:
  - Femoral site (cannulas), Seldinger technique, limited cut-down

- Advantages
  - Easy and rapid implantation if peripheral ECMO
    - No sterno/cardiotomy, local anesthesia, Emergency situations
  - Provides high and stable output flow
  - Simultaneous cardiac and pulmonary assistance: ECMO
  - Bridge to: Recovery, Bridge, Transplantation, Withdrawal
  - “Low cost” (2 - 40 times cheaper / other devices)
Results of ECMO...

In the context of acute refractory cardiac failure
Early extracorporeal membrane oxygenator-assisted primary percutaneous coronary intervention improved 30-day clinical outcomes in patients with ST-segment elevation myocardial infarction complicated with profound cardiogenic shock

Jiunn-Jye Sheu, MD; Tzu-Hsien Tsai, MD; Fan-Yen Lee, MD; Hsiu-Yu Fang, MD; Cheuk-Kwan Sun, MD, PhD; Steve Leu, PhD; Cheng-Hsu Yang, MD; Shyh-Ming Chen, MD; Chi-Ling Hang, MD; Yuan-Kai Hsieh, MD; Chien-Jen Chen, MD; Chiung-Jen Wu, MD; Hon-Kan Yip, MD

Crit Care Med 2010; 38:1810–1817
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Log-Rank $p = 0.003$

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<tr>
<th>Follow-up (Days)</th>
<th>Overall survival (%)</th>
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<th>With ECMO</th>
<th>Without ECMO</th>
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</table>
Latest series of VA-ECMO for AMI

The ENCourAGE mortality risk score and analysis of long-term outcomes after VA-ECMO for acute myocardial infarction with cardiogenic shock

Grégoire Muller¹, Erwan Flecher³, Guillaume Lebreton², Charles-Edouard Luyt¹, Jean-Louis Trouillet¹, Nicolas Bréchotch¹, Matthieu Schmidt¹, Ciro Mastroianni², Jean Chastre¹, Pascal Leprince², Amedeo Anselmi³ and Alain Combes¹*

*Corresponding author

Intensive Care Med 2016
Latest case series of VA-ECMO for CS-AMI

Intensive Care Med 2016

138 Patients

65 ICU survivors

73 In-ICU deaths:
47 Under ECMO
20 Bridged to another device
6 Weaned

44 Weaned

21 Not weaned

12 LVAD
12 Alive
36 Alive
3 Died
5 Lost-to-follow-up

4 Heart transplants
4 Alive

1 BiVAD
1 Heart transplant
1 Alive

1 Impella 5.0

3 Centralized ECMO
3 Alive (1 heart transplant)
6-month follow-up
41% survivors
Latest case series of VA-ECMO for CS-AMI

47% ICU survival

138 Patients

65 ICU survivors

73 In-ICU deaths:
47 Under ECMO
20 Bridged to another device
6 Weaned

Intensive Care Med 2016
Latest case series of VA-ECMO for CS-AMI

Intensive Care Med 2016

32% successful weaning
Latest case series of VA-ECMO for CS-AMI

- 73 in-ICU deaths
- 67 Not weaned
- 6 Weaned
- 47 Died with ECMO still in place
- 20 Bridged
- 13 Centralized ECMO
  - 42 MOF
    - 4 Brain death
    - 1 Post-anoxic encephalopathy
  - 13 MOF
  - 3 LVAD
    - 2 MOF
      - 1 Stroke
    - 2 MOF
  - 2 BIVAD
    - 2 MOF
  - 2 Impella 5.0
    - 6 MOF

*Intensive Care Med 2016*
Latest case series of VA-ECMO for CS-AMI

Intensive Care Med 2016

MOF causes death

42 MOF
4 Brain death
1 Post-anoxic encephalopathy

13 MOF

2 MOF
1 Stroke

2 MOF

2 MOF

2 MOF

6 MOF
ECMO for Fulminant Myocarditis
Outcomes, long-term quality of life, and psychologic assessment of fulminant myocarditis patients rescued by mechanical circulatory support

Mariana Mirabel, MD; Charles-Edouard Luyt, MD, PhD; Pascal Leprince, MD, PhD; Jean-Louis Trouillet, MD; Philippe Léger, MD; Alain Pavie, MD; Jean Chastre, MD; Alain Combes, MD, PhD

Crit Care Med 2011 Vol. 39, No. 5

• 2003 - 2009

• 41 patients refractory cardiogenic shock due to fulminant myocarditis
  • Mean age 38±12 years
  • 66%, women

• Mechanical assistance
  • Thoratec BiVAD (n=6) or
  • ECMO (n=35)
Outcomes, long-term quality of life, and psychologic assessment of fulminant myocarditis patients rescued by mechanical circulatory support

Mariana Mirabel, MD; Charles-Edouard Luyt, MD, PhD; Pascal Leprince, MD, PhD; Jean-Louis Trouillet, MD; Philippe Léger, MD; Alain Pavie, MD; Jean Chastre, MD; Alain Combes, MD, PhD

Crit Care Med 2011 Vol. 39, No. 5
Outcomes, long-term quality of life, and psychologic assessment of fulminant myocarditis patients rescued by mechanical circulatory support

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Crit Care Med 2011 Vol. 39, No. 5

Long term survival: 68%
Heart transplantation in 4 (10%) patients
Independent predictors of ICU death determined at admission:
SAPS II >56 (OR, 10.23)
Troponin Ic >12 g/L (OR, 7.49)
ECMO after complicated cardiac surgery
Early and late outcomes of 517 consecutive adult patients treated with extracorporeal membrane oxygenation for refractory postcardiotomy cardiogenic shock

Ardawan Julian Rastan, MD, PhD, Andreas Dege, MD, Matthias Mohr, MD, Nicolas Doll, MD, PhD, Volkmar Falk, MD, PhD, Thomas Walther, MD, PhD, and Friedrich Wilhelm Mohr, MD, PhD

J Thorac Cardiovasc Surg 2010;139:302-311

- 517 adult patients
  - CABG (37.4%)
  - Isolated valve surgery (14.3%)
  - CABG plus valve surgery (16.8%)
  - Organ transplantation (6.5%)
  - Other combinations (25.0%)
- Thoracic (61%) vs. Extrathoracic (39%)
- Hospital outcomes
  - 63% weaned, 24% discharged alive
- Predictors of hospital death
  - Age>70, diabetes, PreOp renal failure
  - Obesity, Euroscore >20%, Lactate >4
After Heart Transplantation
Predictive risk factors for primary graft failure requiring temporary extra-corporeal membrane oxygenation support after cardiac transplantation in adults

Cosimo D’Alessandro a,*, Jean-Louis Golmard b, Eleodoro Barreda a, Mojgan Laali a, Ralouka Makris c, Charles-Edouard Luyt d, Pascal Leprince a, Alain Pavie a


Objective: Primary graft failure (PGF) is a major risk factor for death after heart transplantation. We investigated the predictive risk factors for severe PGF that require extra-corporeal membrane oxygenation (ECMO) circulatory support after cardiac transplantation. Methods: Between January 2003 and December 2008, 402 adult patients underwent isolated cardiac transplantation at our institution. PGF was defined as the need for ECMO support in the immediate postoperative period. Thirty-three recipient and 37 donor variables were analyzed for the risk of PGF occurrence. Results: PGF occurred in 91 (23%) patients. Predictive risk factors for PGF occurrence were, in the recipient, being aged >60 years (odds ratio (OR) 2.11, p = 0.01) and preoperative mechanical circulatory support (MCS) (OR 2.65, p = 0.01); in the donor, they were mean norepinephrine dose (OR 2.02, p < 0.01), trauma as the cause of death (OR 2.45, p < 0.01), left-ventricle ejection fraction (LVEF) <55% (OR 2.72, p = 0.02), and the ischemic time (OR 1.01, p < 0.01). Weaning and discharge rates after ECMO support for PGF were, respectively, 60% (55/91 patients) and 46% (42/91 patients). The absence of PGF was correlated with improved long-term survival: 78% at 1 year and 71% at 5 years without PGF versus 39% at 1 year and 34% at 5 years with PGF (p < 0.01). Surviving patients treated with ECMO for PGF have similar conditional 1-year survival rates as non-PGF patients: 93% at 3 years and 91% at 5 years without PGF versus 93% at 3 years and 84% at 5 years with PGF (p = 0.46, NS). Conclusions: Occurrence of PGF is a multifactorial event that depends on both donor and recipient profiles. ECMO support is a reliable treatment for severe PGF; furthermore, surviving patients treated with ECMO have the same 1-year conditional survival rates as patients not having suffered a PGF.

Hospital Survival = 46%
La Pitié Heart transplant latest data

\[ p = 0.01 \]

Survival (%)

Days

- No ECMO
- ECMO pre +/- post Htx
- ECMO post Htx
In the case of massive pulmonary embolism
Extracorporeal Life Support for Massive Pulmonary Embolism

Paul Maggio, MD, Mark Hemmila, MD, Jonathan Hafi, MD, and Robert Bartlett, MD

Background: Massive pulmonary embolism is frequently lethal because of acute irreversible pulmonary and cardiac failure. Extracorporeal life support (ECLS) has been used for cardiopulmonary failure in our institution since 1988, and we reviewed our experience with its use in the management of massive pulmonary emboli.

Methods: We reviewed our complete experience with ECLS for massive pulmonary emboli from January 1992 through December 2005. The records of 21 patients were examined and data extracted.

Results: During the study period, 21 patients received ECLS for massive pulmonary emboli. All patients were on vasoactive drugs, acidemic, and hypoxic at the time of institution of ECLS. Eight were in active cardiac arrest. Five were trauma patients, eight had recently undergone an operation, and six had a hypercoagulable disorder. Nineteen of the 21 patients were cannulated for venoarterial bypass and two were placed on venovenous bypass. The average duration of support for survivors was 5.4 days, ranging from 5 hours to 12.5 days. Emboli resolved with anticoagulation in 10 of 13 survivors and 4 of 13 survivors underwent surgical pulmonary embolectomy. Catastrophic neurologic events were the most common cause of mortality in our series; four patients died from intracranial hemorrhage. The overall survival rate was 62% (13/21).

Conclusions: We conclude that emergent ECLS provides an opportunity to improve the prognosis of an otherwise near-fatal condition, and should be considered in the algorithm for management of a massive pulmonary embolism in an unstable patient.

Key Words: Pulmonary embolism, Extracorporeal membrane oxygenator, Extracorporeal life support, Massive pulmonary embolism, Extracorporeal circulation.

Extracorporeal Life Support for Massive Pulmonary Embolism

Paul Maggio, MD, Mark Hemmila, MD, Jonathan Hafi, MD, and Robert Bartlett, MD

**Background:** Massive pulmonary monary emboli. All patients were on va-common cause of mortality in our series;

**Remaining indications for pulmonary embolectomy??**
ECMO for septic shock with severe LV failure
Venoarterial Extracorporeal Membrane Oxygenation Support for Refractory Cardiovascular Dysfunction During Severe Bacterial Septic Shock*  

Bréchot et al, Crit Care Med, 2013

- Venoarterial ECMO  
  - n=222

- Refractory septic shock  
  - n = 14
  - 2 Deaths under ECMO
  - 2 Deaths in ICU
  - 10 Long-term survivors
## Venoarterial Extracorporeal Membrane Oxygenation Support for Refractory Cardiovascular Dysfunction During Severe Bacterial Septic Shock*

Bréchot et al, Crit Care Med, 2013

<table>
<thead>
<tr>
<th>Patients n=14</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Age, yr, median (range)</td>
<td>45 (28–66)</td>
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<tr>
<td>ECMO implantation by UMAC, n</td>
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<tr>
<td>Shock onset-to-ECMO interval, hrs, median</td>
<td>24 (3–108)</td>
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<tr>
<td>Femoral ECMO, n</td>
<td>14</td>
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<tr>
<td>Left ventricular ejection fraction (%), median</td>
<td>16 (10–30)</td>
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<tr>
<td>Catecholamine dose, µg/kg/min, median</td>
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<tr>
<td>Dobutamine, n= 4</td>
<td>17.5 (6–30)</td>
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<tr>
<td>Norepinephrine, n= 9</td>
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<td>Epinephrine, n=13</td>
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<tr>
<td>Pre-ECMO mean arterial pressure, mmHg, median</td>
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<tr>
<td>Pre-ECMO central venous pressure, mmHg, median</td>
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<tr>
<td>Pre-ECMO cardiac index, L/min/m², median</td>
<td>1.3 (0.7–2.2)</td>
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<td>Pre-ECMO systemic resistance vascular index,</td>
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<tr>
<td>SOFA score, median</td>
<td>18 (8–21)</td>
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<tr>
<td>pH, median</td>
<td>7.16 (6.68–7.39)</td>
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<td>Blood lactate, median</td>
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<td>N-Terminal pro-brain natriuretic peptide, pg/mL</td>
<td>29,788 (1,843–35,000)</td>
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Venoarterial Extracorporeal Membrane Oxygenation Support for Refractory Cardiovascular Dysfunction During Severe Bacterial Septic Shock*
The case of a 54 yrs old patient with severe CA pneumonia...

Had VA-ECMO for septic shock and evolution towards cardiogenic shock
At ECMO initiation...
On Day one...
On day 5...

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La Pitié Paris Cardiology Institute  
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www.paris-tcsecmo.org
On day 7...
ECMO after Cardiac Arrest
Venoarterial extracorporeal membrane oxygenation for refractory cardiogenic shock post-cardiac arrest

*Pineton, Intensive Care Med 2016*

954 Venoarterial-extracorporeal membrane oxygenation–treated patients

860 Patients without prior cardiac arrest or refractory cardiac arrest

94 Patients in cardiogenic shock post-cardiac arrest resuscitation

61 Patients for washoff venoarterial extracorporeal membrane oxygenation

31 Patients with refractory shock

94 Patients

One year survival = 27%

3 Deaths after day 28

24 28-day survivors

3 1-year Survivors

22 1-year Survivors

2 Deaths after day 28
Venoarterial extracorporeal membrane oxygenation for refractory cardiogenic shock post-cardiac arrest

*Pineton, Intensive Care Med 2016*
Venoarterial extracorporeal membrane oxygenation for refractory cardiogenic shock post-cardiac arrest

Pineton, Intensive Care Med 2016
ECPR
ECMO for Refractory 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

Yih-Shiang Chen, Jou-Wei Lin, Hsi-Yu Yu, Wen-Jie Ka, Ji-Hsin Jerng, Wen-Jen Chang, Wen-Jone Chen, Shu-Chien Huang, Nai-Hsin Chi, Chih-Hsien Wang, Li-Chin Chen, Pi-Ru Tsai, Sheu-Shen Wang, Jou-Jen Huang, Fanq-Yue Lin


- 3-year prospective observational study
- ECMO for 59 patients
  - Aged 18–75 years
  - With witnessed in-hospital cardiac arrest of cardiac origin
  - Undergoing CPR of more than 10 min
- Compared with patients
  - Receiving conventional CPR
- Matching process based
  - On a propensity-score
Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis


Figure 3: Kaplan-Meier plot of the survival curves in the extracorporeal CPR-M and conventional CPR-M groups for 1 year
Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis

Yih-Shiang Chen*, Jou-Wei Lin*, Hsi-Yu Yu, Wen-Je Kao, Ji-Hsin Jerng, Wen-Tien Chang, Wen-Jone Chen, Shu-Chien Huang, Nai-Hsin Chi, Chih-Heien Wang, Li-Chin Chen, Pi-Ru Tsai, Sheen-Shen Wang, Jou-Jen Huang, Fanq Yue Lin


Figure 1: Relation between CPR duration and the survival rate to discharge
ECPR = extracorporeal CPR. CCPR = conventional CPR.
Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis

Yih-Shiang Chen, Jou-Wei Lin, Ho-Yu Yeh, Wen-Jie Ju, Jin-Sheng Jia, Wei-Tao Chang, Wen-Jen Chen, Shi-Chen Huang, Nan-Hsin Chi, Chi-Hsien Wang, Li-Chen Chen, Pei-Tsu Tsai, Shih-Shen Wang, Huey-Jen Huang, Fang-Yue Lin

Summary

Background: Extracorporeal life support as an adjunct to cardiac resuscitation has shown encouraging outcomes in patients with cardiac arrest. However, there is little evidence about the benefit of the procedure compared with conventional cardiopulmonary resuscitation (CPR), especially when continued for more than 10 min. We aimed to assess whether extracorporeal CPR was better than conventional CPR for patients with in-hospital cardiac arrest of cardiac origin.

Methods: We did a 3-year prospective observational study on the use of extracorporeal life support for patients aged 18 years or older who suffered in-hospital cardiac arrest of cardiac origin undergoing CPR of more than 10 min continued with patients receiving conventional CPR. Data were collected and analyzed by two independent operators. The primary endpoint was survival to hospital discharge and analyzed by the Kaplan-Meier method. This study is registered at ClinicalTrials.gov, number NCT03158285.

Findings: Of the 975 patients with in-hospital cardiac arrest of cardiac origin, 133 were enrolled in the conventional CPR group and 59 were enrolled in the extracorporeal CPR group. Unmatched patients who underwent conventional CPR had a higher survival rate to discharge (log-rank p = 0.001) and a better 1-year survival than those who received conventional CPR (log rank p = 0.007). Between the propensity-score matched groups, there was still a significant difference in survival to discharge [hazard ratio (HR) 0.51, 95% CI 0.36–0.74, p = 0.001] and 1-year survival [HR 0.35, 95% CI 0.23–0.55, p = 0.006] favoring extracorporeal CPR.

Interpretation: Extracorporeal CPR had a short-term and long-term survival benefit consistent with previous reports with in-hospital cardiac arrest of cardiac origin.

Funding: National Science Council, Taiwan.

Introduction

Sudden cardiac arrest still has a low survival rate despite the advances in the field of cardiopulmonary resuscitation (CPR), and this rate has remained unchanged since 1993.1 Investigations have also shown that survival rate declines rapidly when the duration of CPR exceeds 10 min, and even more rapidly if it exceeds 30 min.2,3 Extracorporeal life support as a device for cardiac resuscitation was proposed in the early 1990s.4,5 Advances in technology have allowed such treatment to be deployed rapidly, and several descriptive series investigations have shown encouraging outcomes in patients with cardiac arrest.6 Despite promising results in previous studies, no comparative data have been assessed in adults undergoing CPR related with extracorporeal life support.

Since prestratified conventional CPR has been associated with lower rate of hospital mortality,2 we did a prospective observational study, between 2004 and 2006, of adults with in-hospital cardiac arrest of cardiac origin who received CPR for more than 10 min. We also aimed to assess whether the survival benefit of extracorporeal CPR over conventional CPR continues in previous studies, as might have been due to selection bias.

Methods

Setting: National Taiwan University Hospital, in Taipei, is an extracorporeal life support referral center.7 The CPR team consisted of a senior medical resident, several junior residents, a respiratory therapist, a head nurse, and several registered nurses from the intensive care unit. Each member of the CPR team is certified for advanced cardiac life support. According to American Heart Association guidelines,8 we established an internet-based Utstein style registry system to collect real-time data of patients with in-hospital cardiac arrest since 2003 (webpanel 1). A registered nurse was responsible for data collection. Each event was reviewed for CPR data and clinical practice guidelines for E-CPR. The authors have not disclosed any potential conflicts of interest.

Materials and Methods

Patient enrollment criteria. This study was conducted at Samsung Medical Center, a tertiary academic hospital with 1953 beds. The study was approved by the Institutional Review Board. We retrospectively reviewed our database of in-hospital cardiac arrests between January, 2005 and June 2006, which included data collected according to the Utstein-style guidelines.8 We enrolled patients between the ages of 18 and 99 years who had undergone CPR for >30 min after witnessed inhospital cardiac arrest...
Extracorporeal cardiopulmonary resuscitation in patients with inhospital cardiac arrest: A comparison with conventional cardiopulmonary resuscitation*

Tae Gun Shin, MD; Jin-Ho Choi, MD, PhD; Ik Joon Jo, MD, PhD; Min Seob Sim, MD; Crit Care Med 2011; 39:1–7

- The ECMO team consisted of interventional cardiologists, cardiovascular surgeons, and ECMO technicians available 24H/7D
- ECMO devices available in the cath Lab, CCU, and OR
- Decision of ECMO when
  - No ROSC after 10–20 mins of CPR
  - Recurrent arrest
  - Patient not expected to recover...
- ECMO cart transported to the CPR site
  - Within 5–10 mins during the day
  - Within 10–20 mins during the night shift
- 10–15 min needed to set up extracorporeal life-support
Results of ECPR...

For 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

Kunihiro Mackawa, MD; Katsutoshi Tanno, MD, PhD; Mamoru Hase, MD, PhD; Kazuhisa Mori, MD, PhD; Yasufumi Asai, MD, PhD

Objective: Encouraging results of extracorporeal cardiopulmonary resuscitation for patients with refractory cardiac arrest have been shown. However, the independent impact on the neurologic outcome remains unknown in the out-of-hospital population. Our objective was to compare the neurologic outcome following extracorporeal cardiopulmonary resuscitation and conventional cardiopulmonary resuscitation and determine potential predictors that can identify candidates for extracorporeal cardiopulmonary resuscitation among patients with out-of-hospital cardiac arrest of cardiac origin.

Design: Post hoc analysis of data from a prospective observational cohort.


Patients: A total of 162 adult patients with witnessed cardiac arrest of cardiac origin who had undergone cardiopulmonary resuscitation for >20min (53 in the extracorporeal cardiopulmonary resuscitation group and 109 in the conventional cardiopulmonary resuscitation group).

Interventions: None.

Measurements and Main Results: The primary endpoint was neurologically intact survival at three months after cardiac arrest. We used propensity score matching to reduce selection bias and balance the baseline characteristics and clinical variables that could potentially affect outcome. This matching process selected 24 patients from each group. The impact of extracorporeal cardiopulmonary resuscitation was estimated in matched patients. Intact survival rate was higher in the matched extracorporeal cardiopulmonary resuscitation group than in the matched conventional cardiopulmonary resuscitation group (29.2% [7/24] vs. 8.3% [2/24], log-rank \( p = 0.018 \)). According to the predictor analysis, only pupil diameter on hospital arrival was associated with neurologic outcome (adjusted hazard ratio, 1.39 per 1-mm increase; 95% confidence interval, 1.09–1.78; \( p = 0.008 \)).

Conclusions: Extracorporeal cardiopulmonary resuscitation can improve neurologic outcome after out-of-hospital cardiac arrest of cardiac origin; furthermore, pupil diameter on hospital arrival may be a key predictor to identify extracorporeal cardiopulmonary resuscitation candidates. (Crit Care Med 2013; 41:0–0)

Key Words: cardiopulmonary arrest; cardiopulmonary bypass; cardiopulmonary resuscitation; extracorporeal circulation; extracorporeal membrane oxygenation; 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

Kunihiro Mackawa, MD; Katsutoshi Tanno, MD, PhD; Mamoru Hase, MD, PhD; Kazuhisa Mori, MD, PhD; Yasufumi Asai, MD, PhD

### Sapporo, Japan

#### Critical Care Medicine  May 2013 • Volume 41 • Number 5

<table>
<thead>
<tr>
<th>Time courses</th>
<th>Overall (n = 162)</th>
<th>ECPR (n = 53)</th>
<th>CCPR (n = 109)</th>
<th>P</th>
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<tr>
<td>Arrest to EMS, min</td>
<td>6 (3–10)</td>
<td>6 (2–9)</td>
<td>7 (3–10)</td>
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<td>EMS to hospital, min</td>
<td>26 (19–33)</td>
<td>25 (20–32)</td>
<td>26 (19–34)</td>
<td>0.73</td>
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<tr>
<td>Arrest to hospital, min</td>
<td>33 (25–42)</td>
<td>33 (25–41)</td>
<td>33 (26–43)</td>
<td>0.53</td>
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<tr>
<td>Arrest to basic life support (cardiac arrest time), min</td>
<td>4 (0–9)</td>
<td>2 (0–8)</td>
<td>5 (0–9)</td>
<td>0.13</td>
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<tr>
<td>Arrest to first defibrillation, min</td>
<td>10 (6–16)</td>
<td>10 (7–17)</td>
<td>8 (6–16)</td>
<td>0.40</td>
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<tr>
<td>Arrest to advanced life support, min</td>
<td>23 (17–31)</td>
<td>21 (15–25)</td>
<td>26 (18–32)</td>
<td>0.011</td>
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<tr>
<td>Basic life support to CPR termination (CPR duration), min</td>
<td>52 (43–65)</td>
<td>49 (41–59)</td>
<td>56 (47–66)</td>
<td>0.042</td>
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#### Outcome

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<thead>
<tr>
<th></th>
<th>Overall (n = 162)</th>
<th>ECPR (n = 53)</th>
<th>CCPR (n = 109)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality in the emergency room, n (%)</td>
<td>84 (51.9)</td>
<td>2 (3.8)</td>
<td>82 (75.2)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Survival to discharge, n (%)</td>
<td>24 (14.8)</td>
<td>17 (32.1)</td>
<td>7 (6.4)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Survival at 3 mos, n (%)</td>
<td>20 (12.3)</td>
<td>15 (28.3)</td>
<td>5 (4.6)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Cerebral Performance Category status 1 or 2 at 3 mos, n (%)</td>
<td>11 (6.8)</td>
<td>8 (15.1)</td>
<td>3 (2.8)</td>
<td>0.006</td>
</tr>
</tbody>
</table>
Extracorporeal Cardiopulmonary Resuscitation for Patients With Out-of-Hospital Cardiac Arrest of Cardiac Origin: A Propensity-Matched Study and Predictor Analysis

Kunihiko Mackawa, MD; Katsutoshi Tinno, MD, PhD; Mamoru Hase, MD, PhD; Kazuhisa Mori, MD, PhD; Yasufumi Asai, MD, PhD

Critical Care Medicine  May 2013 • Volume 41 • Number 5

Sapporo, Japan

Neurologically intact survival

Log-rank p = 0.018
Extracorporeal Cardiopulmonary Resuscitation for Patients With Out-of-Hospital Cardiac Arrest of Cardiac Origin: A Propensity-Matched Study and Predictor Analysis

Kunihiro Mackawa, MD; Katsutoshi Tanno, MD, PhD; Mamoru Hase, MD, PhD; Kazuhisa Morishita, MD, PhD; Yasufumi Asai, MD, PhD

Critical Care Medicine May 2013 • Volume 41 • Number 5

Objective: Encouraging results of extracorporeal cardiopulmonary resuscitation for patients with refractory cardiac arrest have been shown. However, the independent impact on the neurologic outcome remains unknown in the out-of-hospital population. Our objective was to compare the neurologic outcome following extracorporeal cardiopulmonary resuscitation and conventional cardiopulmonary resuscitation and determine potential predictors that can identify candidates for extracorporeal cardiopulmonary resuscitation among patients with out-of-hospital cardiac arrest of cardiac origin.

Design: Post hoc analysis of data from a prospective observational cohort.


Patients: A total of 162 adult patients with witnessed cardiac arrest of cardiac origin who had undergone cardiopulmonary resuscitation for >20 min (53 in the extracorporeal cardiopulmonary resuscitation group and 109 in the conventional cardiopulmonary resuscitation group).

Interventions: None.

Measurements and Main Results: The primary endpoint was neurologically intact survival at three months after cardiac arrest. We used propensity score matching to reduce selection bias and balance the baseline characteristics and clinical variables that could potentially affect outcome. This matching process selected 24 patients from each group. The impact of extracorporeal cardiopulmonary resuscitation was estimated in matched patients. Intact survival rate was higher in the matched extracorporeal cardiopulmonary resuscitation group than in the matched conventional cardiopulmonary resuscitation group (29.2% [7/24] vs. 8.3% [2/24], log-rank p = 0.018). According to the predictor analysis, only pupil diameter on hospital arrival was associated with neurologic outcome (adjusted hazard ratio, 1.39 per 1-mm increase; 95% confidence interval, 1.09–1.78; p = 0.008).

Conclusions: Extracorporeal cardiopulmonary resuscitation can improve neurologic outcome after out-of-hospital cardiac arrest of cardiac origin; furthermore, pupil diameter on hospital arrival may be a key predictor to identify extracorporeal cardiopulmonary resuscitation candidates. (Crit Care Med 2013; 41:0–0)

Key Words: cardiopulmonary arrest; cardiopulmonary bypass; cardiopulmonary resuscitation; extracorporeal circulation; extracorporeal membrane oxygenation; out-of-hospital cardiac arrest
Not that simple...
Extracorporeal life support following out-of-hospital refractory cardiac arrest

Morgan Le Guen¹, Armelle Nicolas-Robin¹, Serge Carreira¹, Mathieu Raux¹, Pascal Leprince², Bruno Riou³*, Olivier Langeron¹

Abstract

Introduction: Extracorporeal life support (ECLS) has recently shown encouraging results in the resuscitation of in-hospital (IH) refractory cardiac arrest. We assessed the use of ECLS following out-of-hospital (OH) refractory cardiac arrest.

Methods: We evaluated 51 consecutive patients who experienced witnessed OH refractory cardiac arrest and received automated chest compression and ECLS upon arrival in the hospital. Patients with preexisting severe hypothermia who experienced IH cardiac arrest were excluded. A femorofemoral ECLS was set up on admission to the hospital by a mobile cardiothoracic surgical team.
Extracorporeal life support following out-of-hospital refractory cardiac arrest

Morgan Le Guen¹, Armelle Nicolas-Robin¹, Serge Carreira¹, Mathieu Raux¹, Pascal Leprince², Bruno Riou³*, Olivier Langeron¹

Critical Care 2011, 15:R29
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Results: Fifty-one patients were included (mean age, 42 ± 15 years). The median delays from cardiac arrest to cardiopulmonary resuscitation and ECLS were, respectively, 3 minutes (25th to 75th interquartile range, 1 to 7) and 120 minutes (25th to 75th interquartile range, 102-149). Initial rhythm was ventricular fibrillation in 32 patients (63%), asystole in 15 patients (29%) patients and pulseless rhythm in 4 patients (8%). ECLS failed in 9 patients (18%). Only two patients (4%) (95% confidence interval, 1% to 13%) were alive at day 28 with a favorable neurological outcome. There was a significant correlation (r = 0.36, P = 0.01) between blood lactate and delay between cardiac arrest and onset of ECLS, but not with arterial pH or blood potassium level. Deaths were the consequence of multiorgan failure (n = 43; 47%), brain death (n = 10; 20%) and refractory hemorrhagic shock (n = 7; 14%), and most patients (n = 46; 90%) died within 48 hours.

Conclusions: This poor outcome suggests that the use of ECLS should be more restricted following OH refractory cardiac arrest.
This poor outcome suggests that the use of ECLS should be more restricted following OH refractory cardiac arrest.

Collapse to functional ECMO support should be <60 minutes.

Scoop and run strategy+++
Extracorporeal life support and survival after out-of-hospital cardiac arrest in a nationwide registry: A propensity score-matched analysis

Dong Sun Choi, Taeyun Kim, Young Sun Ro, Ki Ok Ahn, Eui Jung Lee, Seung Sik Hwang, Sung Wook Song, Kyoung Jun Song, Sang Do Shin

Methods: We used a Korean national OHCA cohort database from 2009 to 2013. The inclusion criteria were OHCA adults with presumed cardiac aetiology and resuscitation by emergency medical services (EMS). Patients were excluded if their information onprehospital time intervals or clinical outcomes at hospital discharge was incomplete or not captured. The primary outcome was neurologically favourable survival to discharge. We compared the primary outcomes between the ECLS and non-ECLS groups using a multivariable logistic regression and a propensity score matching analysis.

Results: Of the 119,077 patients with OHCA, 36,547 were included in the analysis. There were 320 patients who received ECLS. There was no significant difference in neurologically favourable survival to discharge
The effects of ECLS, therapeutic hypothermia, and reperfusion therapy on clinical outcomes in the study population.

<table>
<thead>
<tr>
<th></th>
<th>OR(^a) (95% CI)</th>
<th>aOR(^b) (95% CI)</th>
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<tbody>
<tr>
<td><strong>ECLS (+)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge with good neurology</td>
<td>6.26 (4.23–9.25)</td>
<td>0.65 (0.41–1.04)</td>
</tr>
<tr>
<td>Survival to discharge</td>
<td>3.16 (2.37–4.22)</td>
<td>0.38 (0.26–0.54)</td>
</tr>
<tr>
<td><strong>Therapeutic hypothermia (+)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge with good neurology</td>
<td>11.40 (9.50–13.70)</td>
<td>4.44 (3.56–5.54)</td>
</tr>
<tr>
<td>Survival to discharge</td>
<td>13.69 (12.22–15.33)</td>
<td>8.32 (7.30–9.49)</td>
</tr>
<tr>
<td><strong>Reperfusion therapy (+)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge with good neurology</td>
<td>23.02 (18.96–27.96)</td>
<td>7.58 (6.00–9.57)</td>
</tr>
<tr>
<td>Survival to discharge</td>
<td>13.96 (12.05–16.16)</td>
<td>6.37 (5.34–7.59)</td>
</tr>
</tbody>
</table>
Extracorporeal life support and survival after out-of-hospital cardiac arrest in a nationwide registry: A propensity score-matched analysis

Dong Sun Choi, Taeyun Kim, Young Sun Ro, Ki Ok Ahn, Eui Jung Lee, Seung Sik Hwang, Sung Wook Song, Kyoung Jun Song, Sang Do Shin

Univariable and multivariable logistic regression analyses for clinical outcomes based on ECLS implementation in the propensity score-matched cohorts.

Conclusion

In this propensity score-matched cohort using a nationwide OHCA database, OHCA patients who received ECLS did not show better survival outcomes than those who did not receive ECLS. To evaluate the effect size of ECLS on survival outcomes of OHCA patients, well-designed RCTs are urgently needed.

3:1 PSM cohort

<table>
<thead>
<tr>
<th>Outcome</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge with good neurology</td>
<td>1.31 (0.83–2.06)</td>
</tr>
<tr>
<td>Survival to discharge</td>
<td>1.16 (0.83–1.62)</td>
</tr>
</tbody>
</table>
Improvement strategies...
Patient triage

Who should benefit ECPR?
Who should benefit from ECPR?

- Witnessed CA
- No-Flow <5 minutes
- Bystander CPR
- Age <50? 60?
- CA of presumed cardiac origin, Initial shockable rhythm
- Ensure efficient CPR
- EtCO2 >10 mmHg under CPR

**Collapse to ECMO time...**
Improvement strategies

Reduce low-flow

Improvement strategies

*Reduce low-flow*

BCLS

Collapse

7 ± 7 min

ACLS

16 ± 9 min

61 ± 19 min
Improvement strategies

Reduce low-flow

Reduce on-scene time

Sanghavi, JAMA Internal Medicine 2014
Improvement strategies

Change our mind

Lamhaut, *Resuscitation* 2013

2016?
Guidelines...
2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Significant New and Updated Recommendations

- ECPR, also known as venoarterial extracorporeal membrane oxygenation, may be considered as an alternative to conventional CPR for select patients with refractory cardiac arrest when the suspected etiology of the cardiac arrest is potentially reversible during a limited period of mechanical cardiorespiratory support.
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 series have used rigorous inclusion and exclusion criteria to select patients for ECPR. Although these inclusion criteria are highly variable, most included only patients aged 18 to 75 years, with arrest of cardiac origin, after conventional CPR for more than 10 minutes without ROSC. Such inclusion criteria should be considered in a provider’s selection of potential candidates for ECPR.
2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Significant New and Updated Recommendations

Controlled clinical trials are needed to assess the clinical benefits of ECPR versus traditional CPR for patients with refractory cardiac arrest and to determine which populations would most benefit.
Conclusion

• For refractory cardiogenic shock ECMO is...
  • Cheaper, Easier to set up, More versatile
  • ECMO as a bridge to... whatever seems reasonable...
  • Poor outcomes if MOF at the time of ECMO institution
  • Regional network of hospital and a referral medical/surgical center
  • **Mobile Cardiac Assistance Unit** for highly unstable patients

• ECPR for out-of-hospital cardiac arrest?
  • Need for a change in paradigm
  • ECMO decision after only 10 min of refractory CPR
  • “Scoop and Run” to the nearest ECMO center, with CPR machine...
  • Deny indication if Collapse-ECMO will be >60 min
La Pitié “International Diploma in ECMO & Short-Term Respiratory/Circulatory Support”

PALAIS des CONGRÈS de PARIS
June 29-30, 2017

TCS - ECMO
INTERNATIONAL CONGRESS

Program committee:
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www.paris-tcsecmo.org