Should we rescue Out-of-Hospital Cardiac Arrest with ECMO?

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www.reamedpitie.com
Conflict of interest

- Principal Investigator: HEROICS trial
  - HVHF after complicated heart surgery
  - NCT01077349
  - Sponsored by GAMBRO

- Principal Investigator: EOLIA trial
  - VV ECMO in ARDS
  - NCT01470703
  - Sponsored by MAQUET, Getinge Group

- Received honoraria from MAQUET, Getinge Group
When Should Resuscitative Efforts Stop?
The resuscitation team must make a conscientious and competent effort to give patients a trial of CPR and ACLS, provided that the patient has not expressed a decision to forego resuscitative efforts. The final decision to stop efforts can never be as simple as an isolated time interval. Clinical judgment and respect for human dignity must enter into decision making. There is little data to guide this decision.

Emergency medical response systems should not require field personnel to transport every victim of cardiac arrest to a hospital or emergency department (ED). Transportation with continuing CPR is justified if interventions are available in the ED that cannot be performed in the field, such as cardiopulmonary bypass or extracorporeal circulation for victims of severe hypothermia (Class IIb).
ECMO/ECLS

Ready for prime-time for cardiac arrest patients???
Results of ECMO…

For in-hospital cardiac arrest
Outcomes and long-term quality-of-life of patients supported by extracorporeal membrane oxygenation for refractory cardiogenic shock

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

Crit Care Med 2008 Vol. 36, No. 5

ECMO for Acute Cardiogenic Shock

n = 81

DCM
n = 18

AMI
n = 16

Myocarditis
n = 16

PCCS
n = 16

Transplant
n = 10

Other
n = 5

38 Deaths under ECMO
n = 11

9 Deaths after ECMO weaning
n = 2

34 ICU survivors
n = 5

29 Long term survivors
n = 4

42%

36%
Outcomes and long-term quality-of-life of patients supported by extracorporeal membrane oxygenation for refractory cardiogenic shock

<table>
<thead>
<tr>
<th>Factor</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female sex</td>
<td>3.89 (1.06–14.22)</td>
<td>0.04</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>0.13 (0.02–0.78)</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>ECMO under CPR</strong></td>
<td><strong>20.68 (1.09–392.03)</strong></td>
<td><strong>0.04</strong></td>
</tr>
<tr>
<td>Prothrombin activity &lt; 50%</td>
<td>3.93 (1.11–13.85)</td>
<td>0.03</td>
</tr>
<tr>
<td>24 h urine output &lt; 500 mL</td>
<td>6.52 (1.87–22.74)</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Independent predictors of ICU death
Experience with percutaneous venoarterial cardiopulmonary bypass for emergency circulatory support

Birgit Schwarz, MD; Peter Mair, MD; Josef Margreiter, MD; Andreas Pamaroli, MD; Christoph Hoermann, MD; Johannes Bonatti, MD; Karl H. Lindner, MD

Critical Care Medicine
2003; 31:758–764

Long term survivors after CA: 14%
Back from Irreversibility: Extracorporeal Life Support for Prolonged Cardiac Arrest

Massimo Massetti, MD, Marine Tasle, MD, Olivier Le Page, MD, Ronan Deredec, MD,
Gerard Babatasi, MD, Dimitrios Buklas, MD, Sylvain Thuaudet, MD,
Pierre Charbonneau, MD, Martial Hamon, MD, Gilles Grollier, MD,
Jean Louis Gerard, MD, and André Khayat, MD


40 Cardiac Arrest

22 Dead <24H

18 Alive >24H

1 Dead on ECLS

6 Weaned off ECLS

ECLS : 87 H ± 36

[60–140]

9 Bridge to VAD

ECLS : 36 H ± 22

[4–70]

2 Bridge to Tx

ECLS : 126 H ± 50

[72–170]

5 survivors

5 Dead on VAD

2 Weaned off VAD

2 survivors

2 Bridge to Tx

1 survivor
Back from Irreversibility: Extracorporeal Life Support for Prolonged Cardiac Arrest

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40 Cardiac Arrest

22 Dead <24H

18 Alive >24H

35/40 in-hospital CA

8/40, 20% survivors

50% had drug intoxication

5 Dead on VAD

2 Weaned off VAD

2 Bridge to Tx

2 survivors

1 survivor
3-year prospective observational study

ECMO for 59 patients
  - Aged 18–75 years
  - With witnessed in-hospital cardiac arrest of cardiac origin
  - Undergoing CPR for >10 minutes

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

Yih-Shang Chen*, Jou-Wei Lin*, Hsi-Yu Yu, Wen-Je Ko, Jih-Shuin Jeng, Wei-Tien Chang, Wen-Jone Chen, Shu-Chien Huang, Nai-Hsin Chi, Chih-Hsien Wang, Li-Chin Chen, Pi-Ruo Tsai, Shun-Shen Wang, Ju-Yen Huang, Fang-Yue Lin

Lancet 2008; 372: 554-61

Figure 3: Kaplan-Meier plot of the survival curves in the extracorporeal CPR-M and conventional CPR-M groups for 1 year

<table>
<thead>
<tr>
<th>Number at risk</th>
<th>Extracorporeal CPR-M</th>
<th>Conventional CPR-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (days)</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>3</td>
</tr>
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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*, Jue-Wei Lin*, Hsi-Yu Yu, Wen-Je Kuo, Jih-Shuin Jeng, Wei-Tien Chang, Wen-June Chen, Shu-Chien Huang, Nai-Hsien Chi, Chih-Hsien Wang, Li-Chin Chen, Pi-Ru Tsai, Sheen-Shen Wang, Juey-Jen Huang, Fang-Yue Lin


Figure 1: Relation between CPR duration and the survival rate to discharge
ECPR=extracorporeal CPR. CCPR=conventional CPR.
Results of ECMO... For out-of-hospital cardiac arrest
Utstein style study of cardiopulmonary bypass after cardiac arrest

Katsutoshi Tanno MD, Yasushi Itoh MD, PhD, Yoshihiro Takeyama MD, Satoshi Nara MD, Kazuhisa Mori MD, PhD, Yasufumi Asai MD, PhD


Sapporo, Japan
Out-of-Hospital CA, Emergent transfer to the ED

ECMO after only 20 min of unsuccessful CPR

66 ECMO VS 332 standard
  - Better survival
  - Cerebral performance unchanged
Out-of-Hospital CA, Emergent transfer to the ED
ECMO after only 20 min of unsuccessful CPR
66 ECMO VS 332 standard
  ● Better survival
  ● Cerebral performance unchanged
Assessment of outcomes and differences between in- and out-of-hospital cardiac arrest patients treated with cardiopulmonary resuscitation using extracorporeal life support

Eisuke Kagawa*, Ichiro Inoue, Takuji Kawagoe, Masaharu Ishihara, Yuji Shimatani,

Hiroshima, Japan

Resuscitation 81 (2010) 968–973
Aim: Cardiopulmonary resuscitation (CPR) using extracorporeal life support (ECLS) for in-hospital cardiac arrest (IHCA) patients has been assigned a low-grade recommendation in current resuscitation guidelines. This study compared the outcomes of IHCA and out-of-hospital cardiac arrest (OHCA) patients treated with ECLS.

Methods: A total of 77 patients were treated with ECLS. Baselines characteristics and outcomes were compared for 38 IHCA and 39 OHCA patients.

Results: The time interval between collapse and starting ECLS was significantly shorter after IHCA than after OHCA (25 (21–43) min versus 59 (45–65) min, p < 0.001). The weaning rate from ECLS (61% versus 36%, p = 0.03) and 30-day survival (34% versus 13%, p = 0.03) were higher for IHCA compared with OHCA patients. IHCA patients had a higher rate of favourable neurological outcome compared to OHCA patients, but the difference was not statistically significant (26% versus 10%, p = 0.07). Kaplan-Meier analysis showed improved 30-day and 1-year survival for IHCA patients treated with ECLS compared to OHCA patients who had ECLS. However, multivariate stepwise Cox regression model analysis indicated no difference in 30-day (odds ratio 0.94 (95% confidence interval 0.68–1.27), p = 0.67) and 1-year survival (0.99 (0.73–1.33), p = 0.95).

Conclusion: CPR with ECLS led to more favourable patient outcomes after IHCA compared with OHCA in our patient group. The difference in outcomes for ECLS after IHCA and OHCA disappeared after adjusting for patient factors and the time delay in starting ECLS.
Assessment of outcomes and differences between in- and out-of-hospital cardiac arrest patients treated with cardiopulmonary resuscitation using extracorporeal life support

Eisuke Kagawa*, Ichiro Inoue, Takuji Kawagoe, Masaharu Ishihara, Yuji Shimatani

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<th>Odds ratio</th>
<th>95% confidence</th>
<th>p value</th>
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<td><strong>30-day survival</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-of-hospital cardiac arrest</td>
<td>0.94</td>
<td>0.68–1.27</td>
<td>0.67</td>
</tr>
<tr>
<td>Time interval from collapse to start of extracorporeal life support (every 1 min)</td>
<td>0.98</td>
<td>0.96–0.99</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Initial rhythm of ventricular fibrillation</td>
<td>1.32</td>
<td>1.00–1.78</td>
<td>0.048</td>
</tr>
<tr>
<td><strong>1-year survival</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
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<tr>
<td>Initial rhythm of ventricular fibrillation</td>
<td>1.28</td>
<td>0.98–1.70</td>
<td>0.07</td>
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*Corresponding author.
Should We Emergently Revascularize Occluded Coronaries for Cardiac Arrest?
Rapid-Response Extracorporeal Membrane Oxygenation and Intra-Arrest Percutaneous Coronary Intervention
Eisuke Kagawa, MD; Keigo Dote, MD, PhD; Masaya Kato, MD, PhD; Shota Sasaki, MD, PhD; Circulation September 25, 2012

Hiroshima, Japan

Flowchart:
- OHCA ECPR patients, N = 63
  - Emergency coronary angiography, N = 118
    - Non-ACS, N = 37
      - ACS, N = 81
        - Intra-arrest PCI, N = 61
          - ROSB, N = 61
          - Non-ROSBI, N = 0
        - Non-intra-arrest PCI, N = 20
          - ROSB, N = 13
          - Non-ROSBI, N = 7
  - Non-emergency coronary angiography, N = 48
    - Non-ACS, N = 43
      - ACS, N = 5
      - ROSB, N = 2
      - Non-ROSBI, N = 3
Background—Extracorporeal membrane oxygenation (ECMO) and percutaneous coronary intervention (PCI) may be useful in cardiopulmonary resuscitation. However, little is known about the combination of ECMO and intra-arrest PCI. This study investigated the efficacy of rapid-response ECMO and intra-arrest PCI in patients with cardiac arrest complicated by acute coronary syndrome who were unresponsive to conventional cardiopulmonary resuscitation.

Methods and Results—This multicenter cohort study was conducted with the use of the database of ECMO in Hiroshima City, Japan. Between January 2004 and May 2011, rapid-response ECMO was performed in 86 patients with acute coronary syndrome who were unresponsive to conventional CPR. The median age of the study patients was 63 years, and 81% were male. Emergency coronary angiography was performed in 81 patients (94%), and intra-arrest PCI was performed in 61 patients (71%). The rates of return of spontaneous heartbeat, 30-day survival, and favorable neurological outcomes were 88%, 29%, and 24%, respectively. All of the patients who received intra-arrest PCI achieved return of spontaneous heartbeat. In patients who survived up to day 30, the rate of out-of-hospital cardiac arrest was lower (58% versus 28%; P=0.01), the intra-arrest PCI was higher (88% versus 70%; P=0.04), and the time interval from collapse to the initiation of ECMO was shorter (40 [25–51] versus 54 minutes [34–74 minutes]; P=0.002).

Conclusions—Rapid-response ECMO plus intra-arrest PCI is feasible and associated with improved outcomes in patients who are unresponsive to conventional cardiopulmonary resuscitation. On the basis of these findings, randomized studies of intra-arrest PCI are needed. (Circulation. 2012;126:1605-1613.)
Guidelines for indications for the use of extracorporeal life support in refractory cardiac arrest


Possible indication

- Refractory CA
- Cardiac drug Intoxication
- Hypothermia (≤ 32°C)
- Signs of life per-CPR

Uncertainty

Assessment of no-flow duration

- 0-5 min
- > 5 min or no witness

Rhythm assessment

VT, TP, VF

Assessment of low-flow duration

ETCO₂ ≥ 10 mmHg AND Low-flow ≤ 100 min

No indication

Comorbidities

ETCO₂ < 10 mmHg OR Low-flow > 100 min
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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R = 0.36
P = 0.01
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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 favourable 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.
Interferences...

*Between therapeutic ECMO and ECMO for non-heart-beating donation*
Maastricht classification

I  Brought in dead
II  Unsuccessful resuscitation
III  Awaiting cardiac arrest
IV  Cardiac arrest after brain-stem death
V  Cardiac arrest in a hospital inpatient
ECMO for non-heart-beating organ donation

- Expand donor pool (may increase organs available by 20%—Lewis and Valerius, 1999)
- Offers families option of organ donation in cases where brain death criteria is not met
- Practice constitutes active euthanasia?
- Prohibitive conflict of interest for professionals and institutions?
- Adequate social support for dying patients and families?
- Whether unethical and illegal practice is preventable?
Le donneur d'organes n'était pas mort !

C'est une affaire aux frontières de la vie et de la mort. Un dossier qui suscite émotion et réflexion chez les professionnels de la réanimation médicale et chez les responsables chargés de la bioéthique. Qui les oblige à se demander quels critères objectifs permettent de dire à partir de quand un malade sur lequel on pratique une réanimation peut être considéré comme un donneur d'organes. Sachant que ces organes, une fois greffés, permettront de prolonger l'espérance de vie d'autres malades.

Début 2008, à Paris, un homme âgé de 45 ans présente, sur la voie publique, tous les symptômes d'un infarctus du myocarde massif. On apprendra par la suite que, tout en sachant être à haut risque cardio-vasculaire, il ne suivait pas son traitement. Intervention quasi immédiate du SAMU, qui confirme le diagnostic. Une réanimation adaptée est mise en œuvre moins de dix minutes après l'accident cardiaque. Elle ne permet toutefois pas d'obtenir une reprise spontanée des battements du cœur. La présence voisine du groupe hospitalier de La Pitié-Salpêtrière, où l'on peut pratiquer une dilatation des artères coronaires, fait que les médecins choisissent de poursuivre les manoeuvres de réanimation
Organ Donation after Cardiac Death
La Pitié, Refractory CA 2011

Non Heart Beating Organ Donation
n = 26

ECMO
n = 9
Kidney recovered
n = 8
Kidney transplanted
n = 5

Gillot
n = 6
Kidney recovered
n = 6
Kidney transplanted
n = 4

Aborted
n = 11
Contre indications 8
Délais incompatibles 3
The Future... 

But *is-it* reasonable?
UMAC, Paris Marathon, 2010...
45 yrs old male, Cardiac arrest at the 25th km, Bystander CPR
ECMO primed in the SAMU ambulance,
ECMO initiated within 45 min after CA, Anterior MI, PCI, ECMO weaned after 10 days
However, anoxic encephalopathy due to poor initial resuscitation
Conclusion

- Refractory cardiac arrest patients can benefit from ECMO
  - High commitment of the ECMO/ECLS rescue team
  - If ECMO should be initiated within 60 min of CA
  - First organize efficient in-hospital rescue teams

- ECMO for out-of-hospital cardiac arrest?
  - Only for selected indications (intoxication, hypothermia)
  - If ECMO can be initiated within 60 min of CA
  - “Scoop and Run”, with CPR machine...

- ECMO for non-heart-beating donation...
  - Should be preferred in most cases of out-of-hospital CA
La Pitié: 1612 to 2012...