Organ donation in eCPR

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Intro

Incidence of brain death in eCPR

Organ donation in ECMO: our experience

Challenges

Opportunities

No economical COIs. I’m the transplant coordinator of the Brianza area
Cardiac arrest

Before CPR
No flow

During CPR
Low Flow

Defibrillation
No Flow

ROSC
Reperfusion

Ischemia-Reperfusion

Brain
Heart
Other organs
eCPR - venoarterial extracorporeal membrane oxygenation

- eCPR may be considered as an alternative to conventional CPR for selected patients with refractory cardiac arrest when the suspected etiology of the cardiac arrest is potentially reversible during a limited period of mechanical cardiorespiratory support.

eCPR is associated with:

**Improved survival 30 days:**

+ 13 %.  **NNT 7.7**

**Improved favorable neurological outcome at 30 days:**

+14 %.  **NNT 7.1**

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eCPR possible outcomes

- Refractory cardiac arrest
  - Ischemia reperfusion injury
- eCPR
- Survival
  - MOF
  - WLST
  - DCD
- Death
  - WLST Withdrawal/ withholding of life-sustaining therapy
  - MOF multi organ failure
  - BD Brain Death

WLST Withdrawal/ withholding of life-sustaining therapy
MOF multi organ failure
AHA 2015 Recommendations Updated

• We recommend that all patients who are resuscitated from cardiac arrest but who subsequently progress to death or brain death be evaluated for organ donation (Class I, LOE B-NR)
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In-hospital neurologic complications in adult patients undergoing venoarterial extracorporeal membrane oxygenation

The rate of brain death and organ donation in patients resuscitated from cardiac arrest: a systematic review and meta-analysis.

**cCPR** (Conventional Cardiopulmonary Resuscitation)
- **Mortality**: 17,256 (75.9%)
- **Brain death rate**: 8.3% [6.5–10.4] of deaths
- **Organ donation rate**: 4.8% [0.4–11.5] of deaths

**eCPR** (Extracorporeal Cardiopulmonary Resuscitation)
- **Mortality**: 523 (81.2%)
- **Brain death rate**: 27.9% [19.7–36.6] of deaths
- **Organ donation rate**: 7.6% [0.5–17.8] of deaths

**Organ donation rate** in brain death: 59.2% [18.0–95.7] of BD in cCPR vs. 29.4% [4.3–60.8] of BD in eCPR.

**Higher BD rate (> threefold)** vs. **Lower organ donation % in BD**.
## Timing (days) of BD in eCPR

<table>
<thead>
<tr>
<th>Study</th>
<th>Timing (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrie, 2008 [8]</td>
<td>2.5 (2.0–4.2)</td>
</tr>
<tr>
<td>Avalli, 2012 [37]</td>
<td>3 (3–4)</td>
</tr>
<tr>
<td>Calderon, 2014 [26]</td>
<td>3.8 ± 1.7</td>
</tr>
<tr>
<td>Dragancea, 2013 [6]</td>
<td>5.0 ± 1.3</td>
</tr>
<tr>
<td>Fagnoul, 2013 [38]</td>
<td>0.1 [0.1–2]</td>
</tr>
<tr>
<td>Nielsen, 2013 [32]</td>
<td>3.1 ± 1.2</td>
</tr>
<tr>
<td>Pozzi, 2016 [44]</td>
<td>1.3 ± 2.1</td>
</tr>
<tr>
<td>Rundgren, 2010 [34]</td>
<td>5.3 ± 1.5</td>
</tr>
<tr>
<td>Stammet, 2009 [36]</td>
<td>2 (1–3)</td>
</tr>
<tr>
<td><strong>Overall (mean ± SE)</strong></td>
<td><strong>3.2 ± 0.4</strong></td>
</tr>
</tbody>
</table>
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### 112 eCPR CA patients
January 2011-September 2016

- **Age**: 57.8 ± 11.1, Male 82.1%, VF/TV 58.9%
- **TTM**: 86.6% (97/112), Target 34.2 ± 0.8°
- **First neurologic evaluation**: 2.33 ± 1.2 days

<table>
<thead>
<tr>
<th></th>
<th>OHCA</th>
<th>IHCA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patients (n)</strong></td>
<td>72 (64.3%)</td>
<td>40 (35.7%)</td>
</tr>
<tr>
<td><strong>CPR bystanders (n)</strong></td>
<td>60 (83.3%)</td>
<td>40 (100%)</td>
</tr>
<tr>
<td><strong>LUCAS (n)</strong></td>
<td>23 (31.9%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Mean no flow time (min)</strong></td>
<td>4 ± 4</td>
<td>0.5 ± 0.1</td>
</tr>
<tr>
<td><strong>Mean low flow time (min)</strong></td>
<td>62 ± 19.3</td>
<td>27 ± 18</td>
</tr>
<tr>
<td><strong>Overall CA time (min)</strong></td>
<td>65.9 ± 19.3</td>
<td>27.7 ± 18</td>
</tr>
</tbody>
</table>

112 eCPR CA patients

- 82 Dead (73.2%)
  - 25 Brain dead pt, (30.4% of deaths)
  - 57 Dead for other causes

- 30 Alive (26.8%)
  - 6 months CPC 1-2 83.33%

Diagnosis of BD at 4.68 ± 3.5 days

<table>
<thead>
<tr>
<th>First neurological evaluation</th>
<th>BD patients (N = 25)</th>
<th>Alive patients (N = 30)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS at 72h</td>
<td>4 ± 1</td>
<td>7 ± 3</td>
<td>0.0002</td>
</tr>
<tr>
<td>CT scan</td>
<td>20</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>– Normal</td>
<td>0 (0%)</td>
<td>17/25 (68%)</td>
<td></td>
</tr>
<tr>
<td>– Diffuse hypoxic injury</td>
<td>17/20 (85%)</td>
<td>6/25 (24%)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>– Regional ischemia</td>
<td>0 (0%)</td>
<td>2/25 (8%)</td>
<td></td>
</tr>
<tr>
<td>– Haemorrhage</td>
<td>3/20 (15%)</td>
<td>0/25 (0%)</td>
<td></td>
</tr>
<tr>
<td>EEG indices of poor outcomes</td>
<td>18/22 (81.8%)</td>
<td>13/26 (50%)</td>
<td>0.017</td>
</tr>
<tr>
<td>Epileptic status</td>
<td>1/22 (4.5%)</td>
<td>10/26 (38.7%)</td>
<td>0.005</td>
</tr>
<tr>
<td>Absence of pupillary light reflex</td>
<td>11/17 (64.7%)</td>
<td>0/30 (0%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Absence of corneal reflex</td>
<td>14/17 (82.4%)</td>
<td>2/30 (6.7%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Absence of carinal reflex</td>
<td>14/17 (82.4%)</td>
<td>0/30 (0%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Absence of bilateral N20 SSEPs</td>
<td>5/8 (62.5%)</td>
<td>1/27 (3.7%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>First NSE determination, ng/ml</td>
<td>202.85 ± 213</td>
<td>55.1 ± 38</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Factor</td>
<td>BD vs all OR (95% CI)</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-----------------------</td>
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<td></td>
</tr>
<tr>
<td>EEG indices of poor outcome</td>
<td>7.34 (2.16-24.99)</td>
<td>0.001*</td>
<td></td>
</tr>
<tr>
<td>Absence of epileptic status</td>
<td>0.09 (0.01-0.75)</td>
<td>0.03*</td>
<td></td>
</tr>
<tr>
<td>Absence of pupillary light reflex</td>
<td>0.07 (0.02-0.26)</td>
<td>&lt;0.0001*</td>
<td></td>
</tr>
<tr>
<td>Absence of corneal reflex</td>
<td>0.09 (0.02-0.34)</td>
<td>0.0005*</td>
<td></td>
</tr>
<tr>
<td>Absence of carinal reflex</td>
<td>0.05 (0.01-0.21)</td>
<td>&lt;0.0001*</td>
<td></td>
</tr>
<tr>
<td>Absence of bilateral N20 SSEPs</td>
<td>0.07 (0.01-0.40)</td>
<td>0.003*</td>
<td></td>
</tr>
<tr>
<td>GCS at 72h</td>
<td>0.69 (0.47-1.01)</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>First NSE determination</td>
<td>1.01 (1.00-1.01)</td>
<td>0.05*</td>
<td></td>
</tr>
</tbody>
</table>

25 Brain death, 30.4% of deaths

2 Not eligible (sepsis, 8%)
3 No family consent (12%)
20 Eligible for organ donation (80%)

14 Donors, rate of organ donation 56% of BD

23 kidneys, 12 livers, 4 lungs
89.74% good functional recovery in recipients

6 not suitable for transplant in the OR
Organ biopsy (n=3), Abdominal ischemia (n=5)

112 eCPR CA patients

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Catastrophic Brain Injury (CBI)

Continuing deterioration despite intervention, with potential to evolve to brain death

Cessation of brain function with no possibility to resume by any means

Mechanical ventilation (may occur prior to CBI) and neuro-protective interventions

Biological events after death

Preconditions & confounders, Minimum Acceptable Clinical Standard, and Additional Testing defined for N-1, N-2, N-3

Neurological dying sequence

N-1
Continuing deterioration despite intervention, with potential to evolve to brain death

N-2
Cessation of brain function

N-3
Cessation of brain function with no possibility to resume by any means

Challanges

• Identification of the BD patient

• Conditions that may depress apparent level of consciousness
  – Recent use of sedatives, opiates, or neuromuscular blocker in the TTM phase

• Conditions that may interfere with reliable apnea testing
  – Physiological instability
  – ECMO
Identification of the BD patient

Cessation of brain function with no possibility to resume by any means

Serial evaluations

- Neuroexam
- TCD
- EEG (mandatory in Italy)
- AngioCT

- GCS
- Reflexes
- Apnea test
Infrared pupillometry

Variables:
- Size (mm)
- Latency (ms)
- Constriction Velocity (mm/s)
- Dilation Velocity (mm/s)
- Percentage or Constriction Change (%)
Prognostication of neurologic outcome

Absent pupillary light reflexes
Absent corneal reflexes
Absent motor responses

Association between quantitative pupillary light reflex (PLR) at 48 hours after cardiac arrest and CPC scores

Katherine E. Eder et al. Neurology 2012;79:e79
Apnea test in eCPR patients

Mechanical ventilation: MINUTE VENTILATION 5 L/min plus adequate PEEP level to prevent derecruitment.

ECMO patients

The extracorporeal blood flow is not modified, extracorporeal gas flows are reduced to 1 L/min and extracorporeal FIO₂ is increased to 100%

O₂ provided through AMBU bag with PEEP valve and capnometer

Pulse oximeter


ECMO patients blue boxes

Step 2 First apnea test
Step 4 Second apnea test
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Devastating brain injuries

• When resources allow, all DBI patients without a known pre-existing objection to treatment should be aggressively resuscitated for an initial period to maximize the likelihood of potential neurologic recovery or the opportunity for organ donation (strong recommendation, expert opinion).

• We recommend using a 72-h observation period to determine clinical response and delaying decisions regarding withdrawal of life-sustaining treatment in the interim (strong recommendation, moderate quality of evidence).

eCPR

PTCA, TTM

Coma at rewarming

Exclude confounders

Multimodal neuroprognostication

Good outcome

Negative outcome

Family discussion

BD criteria

Certificate BD

Evaluate/Optimize organ for donation

Think about organ donation. Test BD criteria. Evaluate organ function.
eCPR

PTCA, TTM

Coma at rewarming

Exclude confounders

Multimodal neuroprognostication

Good outcome

Negative outcome

Family discussion

No BD criteria

WLST

Evaluate/Optimize organ for cDCD
Conclusions

BD is one of the possible negative outcomes after eCPR (25-30%)

Organ donation in BD eCPR patients is possible (up to > 50% BD), transforming a medical “failure” in an opportunity for other sick patients

Identification of potential organ donors is challenging

The organ retrieved could be transplanted with good outcomes in the recipients