The ECMO retrieval team

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Conflict of interest

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

• Received honoraria from
  • MAQUET, GAMBRO, ALUNG
The First Mobile ECMO rescue teams

The Ann Arbor experience...
A Review of 100 Patients Transported on Extracorporeal Life Support


ASAIO Journal 2002

- May 1990 / Jan 1999
- 100 patients
  - 68 Adult
  - 32 Pediatric
- Severe respiratory or cardiac failure
  - 53 VV ECMO
  - 47 VA ECMO
- “Old fashioned ECMO”
  - Roller pump
  - Kolobow silicone Oxygenator
A Review of 100 Patients Transported on Extracorporeal Life Support


ASAIO Journal 2002
# A Review of 100 Patients Transported on Extracorporeal Life Support


## Complications During ECLS Transport

<table>
<thead>
<tr>
<th>Transport-Related Complications</th>
<th>Incidence in 100 Transports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power failure (vehicle power supply or back-up battery failure)</td>
<td>10 (4 also with back-up battery pack failure)</td>
</tr>
<tr>
<td>Circuit tubing leakage</td>
<td>3</td>
</tr>
<tr>
<td>Circuit rupture</td>
<td>1</td>
</tr>
<tr>
<td>Membrane lung thrombosis</td>
<td>1</td>
</tr>
<tr>
<td>Membrane lung leakage</td>
<td>1</td>
</tr>
<tr>
<td>Hypocapnia/hyperventilation</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

## ECLS Transport and Survival Data

<table>
<thead>
<tr>
<th>Transport/Survival Data</th>
<th>Adult</th>
<th>Pediatric</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of transports</td>
<td>68</td>
<td>32</td>
<td>100</td>
</tr>
<tr>
<td>Mode of bypass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venoarterial</td>
<td>24</td>
<td>23</td>
<td>47</td>
</tr>
<tr>
<td>Venovenous</td>
<td>44</td>
<td>9</td>
<td>53</td>
</tr>
<tr>
<td>Total bypass time (hrs)</td>
<td>237 ± 233</td>
<td>218 ± 240</td>
<td>231 ± 212</td>
</tr>
<tr>
<td>Successful decannulation</td>
<td>n = 44 (64.7%)</td>
<td>n = 25 (78.1%)</td>
<td>n = 69 (69%)</td>
</tr>
<tr>
<td>Survival to discharge</td>
<td>n = 41 (60.3%)</td>
<td>n = 25 (78.1%)</td>
<td>n = 66 (66%)</td>
</tr>
</tbody>
</table>
More recent reports...
Inter-hospital transportation of patients with severe acute respiratory failure on extracorporeal membrane oxygenation – national and international experience

Abstract  
Objective: To evaluate the experiences and results from inter-hospital transportation of patients with acute respiratory failure on extracorporeal membrane oxygenation (ECMO).

Design: Observational, descriptive study.

Setting: Tertiary referral center in a University Hospital.

Subjects and methods: When standard ECMO criteria were fulfilled and the patient considered too unstable for a conventional transport, the mobile ECMO team cannulated the patient for ECMO at the referring hospital. The patients were then transported to our ECMO center by ground ambulance, helicopter or fixed-wing vehicle. Patients were also transported on ECMO from our ECMO center to other centers due to shortage of available ECMO beds.

Results: 29 patients (15 neonates, seven pediatric, and seven adult patients) with acute respiratory failure were transported on ECMO on a was 2.2 h (range 1.25–4.25 h). The median time that the transport team was out was 10 h (range 5.5–36.5 h) and the median time with the patient was 6 h (range 3–30.5 h). The distance of transport ranged from 4–1,500 km. Six transports were international. No patient complications occurred during the transports. Two technical complications related to the transport vehicle were encountered. One ambulance compressor malfunctioned. During one helicopter transport, one out of two electric supply circuits malfunctioned. The patients were not affected. Twenty-one of the 29 patients survived to discharge (72%). None of the deaths was transport related.

Conclusions: Tertiary intensive care units and ECMO centers require a dedicated transport team. ECMO transports can be performed safely for all age groups for long distances, probably throughout most of Europe.
Inter-hospital transportation of patients with severe acute respiratory failure on extracorporeal membrane oxygenation – national and international experience

- 29 Patients:
  - 15 neonates, 7 pediatric, 7 adults
  - Acute respiratory failure
- Distance: 4-1500 km
- No patient’s complications
  - During transportation
- Survive to discharge: 72%

Results: 29 patients (15 neonates, seven pediatric, and seven adult patients) with acute respiratory failure were transported on ECMO on a total of 13 missions. A total of 29 patients (15 neonates, seven pediatric, and seven adult patients) with acute respiratory failure were transported on ECMO on a total of 13 missions. A total of 29 patients (15 neonates, seven pediatric, and seven adult patients) with acute respiratory failure were transported on ECMO on a total of 13 missions. A total of 29 patients (15 neonates, seven pediatric, and seven adult patients) with acute respiratory failure were transported on ECMO on a total of 13 missions.

Conclusions: Tertiary intensive care units and ECMO centers require a dedicated transport team. ECMO transports can be performed safely for all age groups for long distances, probably throughout most of Europe.
Retrieval of critically ill adults using extracorporeal membrane oxygenation: an Australian experience

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J. Ratchford
B. Burns
R. Herkes
A. Jackson
B. Plunkett

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Abstract Purpose: A retrieval program was developed in New South Wales (NSW), Australia to provide extracorporeal membrane oxygenation support (ECMO) for the safe transport of adults with severe, acute respiratory or cardiac failure. We describe the development and results of this program and the impact of the 2009 H1N1 epidemic on this service.

Methods: An observational study of all patients who were retrieved on ECMO support in NSW, from March 1, 2007 to June 1, 2010, was carried out.

Results: Forty adult patients were retrieved on ECMO support (median age 34 years). The indications for retrieval were respiratory in 38 patients (of whom 16 were confirmed or suspected H1N1 cases) and cardiac in 2 patients. Two other patients died after referral but before ECMO support could be established. Patients were transported by road (n = 26, 65%), medical retrieval jet (n = 10, 25%) and helicopter (n = 4, 10%). The median retrieval distance was 250 km (range 12–1,960 km). Thirty-four patients (85%) survived to hospital discharge. Survival for respiratory indications was 87% (33/38 patients) and 50% (1/2 patients) for cardiac indications. There were no deaths or major morbidity associated with these retrievals.

Conclusions: Patients with very severe respiratory failure, which was considered to preclude conventional ventilation for safe transfer to tertiary centres, were managed by an ECMO referral and retrieval program in NSW and had a high rate of survival. This program also enhanced the capacity of the state to respond to a surge in demand for ECMO support due to the H1N1 epidemic, although the role of ECMO in respiratory failure is not yet well defined.

Keywords Extracorporeal membrane oxygenation · Retrieval · Acute respiratory distress syndrome · Adults
• 40 adult Patients:
  • 38 Acute respiratory failure (16 H1N1)
  • 2 had cardiogenic shock
• Distance: 12-2000 km
• No major patient’s complications
• During transportation
• Survive to discharge: 85%
National/regional organization...
Retrieval of critically ill adults using extracorporeal membrane oxygenation: an Australian experience
The NSW indications for ECMO referral

Forrest et al
Intensive Care Med, 2011

Non-cardiogenic respiratory failure
- Potentially reversible
  - Pneumothorax / large pleural effusion drained
- No contra-indications to veno-venous ECMO

Cardiogenic shock
- Potentially reversible OR candidate for destination Rx
- Refractory to maximal medical therapy / IABP
- PaO2 / FiO2 > 100mmHg
- No contraindications to veno-arterial ECMO

Optimal ventilation (including PCV / PEEP ≥ 10cmH2O)
- Consider: prone ventilation / inhaled NO / iloprost

PaO2 / FiO2 < 100mmHg
AND pCO2 > 100mmHg for > 1 hour

Absolute contraindications to all forms of ECMO
- Significant pre-existing co-morbidity, such as irreversible neurological condition, cirrhosis with ascites, encephalopathy, history of variceal bleeding, active malignancy with predicted limited survival, AIDS.

Relative contraindications to all forms of ECMO
- Age > 65
- Multiple trauma with uncontrolled haemorrhage
- Multiple organ failure

Absolute contraindications to veno-venous ECMO (for respiratory failure)
- Severe pulmonary hypertension (mPAP > 50mmHg)
- Severe right or left heart failure (EF < 25%)
- Cardiac arrest

Relative contraindications to veno-venous ECMO
- High pressure, high FiO2 IPPV for > 1 week

Absolute contraindications to veno-arterial ECMO (for cardiac failure)
- Severe aortic valve regurgitation
- Aortic dissection

Relative contraindications to veno-arterial ECMO
- Severe peripheral vascular disease

PaO2 / FiO2 < 100mmHg for > 48h

Immediate consultation

PaO2 / FiO2 < 60mmHg

Delayed consultation
The French airbridge for circulatory support in the Caribbean

Guillaume Lebreton*, Bruno Sanchez, Jean-Luc Hennequin, Dabor Resière, Didier Hommel, Christian Léonard, Hossein Mehdaoui and François Roques
The Mobile ECMO rescue team at La Pitié
ECMO program at La Pitié, Paris

Portable ECMO Program

Total
Post CPB
Medical


0 50 100 150 200 250 300 350 400 450

La Pitié Paris Cardiology Institute
alain.combes@aphp.fr
www.paris-ecmo.org
Organization of the mobile ECMO rescue team
Organization of the mobile ECMO rescue team

- Dedicated team
  - Coordinating staff
  - Equipment: ECMO device and supplies
- Available 24 h/7d
- Perfusionist AND Heart-Surgery Fellow
- Tight collaboration with the emergency retrieval system: SAMU
- Network of >40 ICUs in the great Paris
Organization of the mobile ECMO rescue team

• Phone call to full ECMO support: 60 to 120 min
  • Phone call to departure from La Pitié: 30 min
  • Transportation: 25 to 60 min
  • Installation: 15 min
  • Implantation: 25 min
  • Hemostasis, reperfusion, closure: 25 min

• The way back to La Pitié: 60-120 min
  • Preparing patient’s transfer on ECMO: 20 min
  • Transferring the patient (SAMU+perfusionist): 60 min
    • Room → SAMU Ambulance: 10 min
    • Installation in SAMU ambulance: 15 min
    • Drive to La Pitié: 20-50 min
    • Ambulance to room: 10 min
    • Installation in ICU room: 30 min

• Total duration of the ECMO retrieval: 120-240 min
Organization of the mobile ECMO rescue team
The mobile ECMO rescue team
Emergency circulatory support in refractory cardiogenic shock patients in remote institutions: a pilot study (the cardiac-RESCUE program)

Sylvain Beurtheret\textsuperscript{1*†}, Pierre Mordant\textsuperscript{1†}, Xavier Paoletti\textsuperscript{2}, Eloi Marijon\textsuperscript{3,4,5}, David S. Celermajer\textsuperscript{6}, Philippe Léger\textsuperscript{1}, Alain Pavie\textsuperscript{1}, Alain Combes\textsuperscript{7}, and Pascal Leprince\textsuperscript{1}

The Mobile ECMO rescue team at La Pitié: 2005-2009 experience for refractory cardiac failure...
The mobile ECMO rescue team

104 phone calls for RCS from 37 remote hospitals

93 MUCA displacements

6 died before arrival of MUCA

87 patients underwent V-A ECMO included in Cardiac-RESCUE Program

12 died under ECMO (MOF) in remote institution

75 patients stabilized and transferred in a tertiary care center
The mobile ECMO rescue team

<table>
<thead>
<tr>
<th>Centres</th>
<th>Patients</th>
<th>Median distance (range), Km</th>
<th>Median time (range), min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paris urban agglomeration (7 centres)</td>
<td>25 (29)</td>
<td>4 (4-18)</td>
<td>4 (4-26)</td>
</tr>
<tr>
<td>Paris region (26 centres)</td>
<td>54 (62)</td>
<td>13 (4-53)</td>
<td>19 (7-46)</td>
</tr>
<tr>
<td>Outside Paris region (4 centres)</td>
<td>8 (9)</td>
<td>88 (87-243)</td>
<td>60 (64-134)</td>
</tr>
<tr>
<td>Total (37 centres)</td>
<td>87</td>
<td>17 (4-243)</td>
<td>20 (4-134)</td>
</tr>
</tbody>
</table>
The mobile ECMO rescue team

- 87 patients 2005-2009
  - 57 males, 28 females
  - Mean age: 46.1 [13-76]

- Etiologies
  - AMI 46%
  - Chronic DCM 16%
  - Other Acute HF= 38%
    - Myocarditis 14
    - Intoxication 5
    - Rythmic 4
    - Post-Partum 3
    - Hypoxemia 2
    - Takotsubo 3
    - Anaphylactic 1
    - Septic 1
75 patients stabilized and transferred in a tertiary care center

39 ECMO weaning

31 BTR
- 27 Recovery
- 1 Lung Tx

3 BTT
- 4 Heart Tx

5 BTB
- 1 TAH

36 died under ECMO
- 31 MOF
- 5 Brain death (1 organ donor)

4 died after bridge to
- 1 TAH
- 2 L-VAD
- 1 Bi-VAD

4 died after ECMO weaning

32 patients alive at discharge

4 died after Hospital discharge (4, 12, 27 and 42 months)

30 patients alive at 1 year
One year survival = 35%

75 patients stabilized and transferred in a tertiary care center

39 ECMO weaning

31 BTR

3 died after ECMO weaning

3 BTT

5 BTB

36 died under ECMO
- 31 MOF
- 5 Brain death (1 organ donor)

4 died after bridge to
- 1 TAH
- 2 L-VAD
- 1 Bi-VAD

32 patients alive at discharge

4 died after Hospital discharge (4, 12, 27 and 42 months)

30 patients alive at 1 year
### Comparison with in-house patients

<table>
<thead>
<tr>
<th></th>
<th>Study group</th>
<th>In-house</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>N = 87</strong></td>
<td><strong>N=123</strong></td>
</tr>
<tr>
<td>Age (mean±SD, years)</td>
<td>46.1 ± 14.8</td>
<td>49.2 ± 14.8</td>
</tr>
<tr>
<td>Male gender</td>
<td>59 (68%)</td>
<td>88 (70%)</td>
</tr>
<tr>
<td>Dilated cardiomyopathy</td>
<td>14 (16%)</td>
<td>57 (46%)</td>
</tr>
<tr>
<td>Acute myocardial infarction</td>
<td>40 (46%)</td>
<td>52 (42%)</td>
</tr>
<tr>
<td>Non dilated, non ischemic cardiopathy</td>
<td>33 (38%)</td>
<td>14 (12%)</td>
</tr>
<tr>
<td>Lactate (mmol/L)</td>
<td>9.2 ± 6.7</td>
<td>6.6 ± 5.7</td>
</tr>
<tr>
<td>pH (mean±SD)</td>
<td>7.23 ± 0.17</td>
<td>7.3 ± 0.19</td>
</tr>
<tr>
<td>On Catecholamines</td>
<td>100%</td>
<td>95%</td>
</tr>
<tr>
<td>SAPS II</td>
<td>70 ± 16.5</td>
<td>66± 14.5</td>
</tr>
<tr>
<td>PaO2/FiO2 &lt;200 (%)</td>
<td>45 (52%)</td>
<td>9 (7%)</td>
</tr>
</tbody>
</table>
Comparison with in-house patients

• In the multivariate analysis model
  • Adjusted for the inotropic score
  • Stratified for diagnosis and CPR at ECMO start
• Mortality at hospital discharge was **not statistically different** between groups
  • OR 1.48, 95% CI 0.72–3.00, p=0.29
From the 90’s to the XXIst century...
First experience with the ultra compact mobile extracorporeal membrane oxygenation system Cardiohelp in interhospital transport

A. Philipp et al. / Interactive CardioVascular and Thoracic Surgery xx (2011)

University Hospital Regensburg, Regensburg, Germany
8.000 km Transatlantic ECMO
8,000 km Transatlantic ECMO

12 patients transported from Martinique/La Réunion To La Pitié, Paris

Commercial transatlantic flight
No incident during flight
International ECMOnet

To promote research on ECMO
Abstract

The use of extracorporeal membrane oxygenation (ECMO) for severe acute respiratory failure (ARF) in adults is growing rapidly given recent advances in technology, even though there is controversy regarding the evidence justifying its use. Because ECMO is a complex, high-risk, and costly modality, at present it should be conducted in centers with sufficient experience, volume, and expertise to ensure it is used safely. This position paper represents the consensus opinion of an international group of physicians and associated health-care workers who have expertise in therapeutic modalities used in the treatment of patients with severe ARF, with a focus on ECMO. The aim of this paper is to provide physicians, ECMO center directors and coordinators, hospital directors, health-care organizations, and regional, national, and international policy makers a description of the optimal approach to organizing ECMO programs for ARF in adult patients. Importantly, this will help ensure that ECMO is delivered safely and proficiently, such that future observational and randomized clinical trials assessing this technique may be performed by experienced centers under homogeneous and optimal conditions. Given the need for further evidence, we encourage restraint in the widespread use of ECMO until we have a better appreciation for both the potential clinical applications and the optimal techniques for performing ECMO.

Keywords: extracorporeal membrane oxygenation; acute respiratory distress syndrome; hospital organization; critical care networks; position article
Mobile ECMO Team

Each ECMO network should ideally create mobile ECMO teams to retrieve patients and to deal with patients who have critical cardiopulmonary failure refractory to conventional therapy. Their coordination would run through the tertiary ECMO referral center. This mobile team should be available 24 hours a day, 7 days a week and employ experienced personnel trained in the transport of critically ill patients, insertion of ECMO cannulae, as well as circuit and patient management. The team variably includes a mix of physicians, transport specialists, nurses, perfusionists, or other ECMO specialists. Imaging requirements at
Conclusion

• ECMO is a life-saving procedure
  • Costly
  • Needs a lot of experience in the management of patients and devices
• ECMO programs conducted in large referral centers
• Should include a mobile ECMO retrieval team
  • Available 24H/7D
  • Helicopter/plane retrieval for large areas
  • Nationwide or regional ECMO networks necessary