ARDS
When should I decide for ECMO

Ostrava 2017
Kenneth ”Palle” Palmer
Karolinska University Hospital
ECMO Centre of Karolinska

1986  Animal studies
1987  First neonatal patient
1995  First adult patient
1996  First ECMO transport
1998  Moved till Karolinska
2005  Our own ICU 2-3 beds
2007  Center of excellence
2010  New ICU with 6 beds
Patient / year

Number

Year

Neo
Ped
Adult
Total

Neo Centrum Karolinska

3 ECMO Centrum Karolinska
ECMO centers and members of ELSO
# ECLS Registry Report

## International Summary

**July, 2015**

## Overall Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Total Patients</th>
<th>Survived ECLS</th>
<th>Survived to DC or Transfer</th>
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<tr>
<td>ECPR</td>
<td>1,985</td>
<td>791</td>
<td>589</td>
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Neonatal ECMO

**Indication**
Acute reversible pulmonary disease or Circulation disease

**Contraindication**
ICH gr III - IV
BW < 1500 g
GA < 33 weeks
UK Trial 1993-95

"Clinical effectiveness of ECMO in neonates with severe but potentially reversible respiratory failure"

Oxygenation index > 40

RCT in 185 newborn infants

Traditional intensive care - 42% survival

ECMO survival rate - 68% survival
Indication neonates (Mean and median airway pressure)

Oxygenation index = \[
\text{Median airway pressure} \times 100 \times \text{FiO}_2
\]
\[
\text{pO}_2 \text{ (mm Hg)}
\]

\[\text{OI} > 40\]

Post ductal pO2

Mean airway pressure is with the Inspiration time 50%

Peak pressure = PEEP pressure / 2 + PEEP pressure

ie. \[
(30-4) \times 2 + 4 \times 100 \times 1,0
\]
\[
17 \times 100 \times 1,0
\]
\[
\text{OI} = 40
\]
\[
43 \text{ (5,7 kpascal)}
\]
\[
43
\]

With a inspiration time of 0,35 secs

32 mm Hg (4,3 kpascal)
Contraindication

Late stage cancer
Bone marrow transplant

Newborns < 1500 gram lack of cannulae size
Adult > 75 years ( relative – biological age )
> 125 kg ( relative )

Pre-ECMO ventilation time is not a limitation
Pediatrisk ECMO

Viral pneumonia
Bacterial pneumonia
Pneumocystis pneumonia
Aspiration
ARDS postop / trauma
Sepsis
Myocarditis

Pertussis with RS virus  2 month old  -  10% surviving
Septic shock day 1-3

Antibiotics is absolute crucial

Influenza and a septic shock in Sweden it’s not uncommon with staphylococcus with PVL-gene which melts down the lung

The patient need Vancomycin and Klindamycin immediately and for at least 3 week
Meropenen is also added

A CT-scan should be performed as early as possible – x-ray not good enough – The patient will be more complicated to move to CT-scan within the next days
CVVHDF – to control the fluid

Try to reduce sedation a little so the patient can have a little of his own blood pressure

Withdraw fluid if possible.

Most patient is extremely sedated
The first 3 -(5) days

The lungs is still available
Try a soft recruitment
Try increase or decrease PEEP depends on patient reaction
Try prone positioning
Prone Positioning in Severe Acute Respiratory Distress Syndrome

Claude Guérin, M.D., Ph.D., Jean Reignier, M.D., Ph.D., Jean-Christophe Richard, M.D., Ph.D., Pascal Beuret, M.D.,

CONCLUSIONS

In patients with severe ARDS, early application of prolonged prone-positioning sessions significantly decreased 28-day and 90-day mortality. (Funded by the Programme Hospitalier de Recherche Clinique National 2006 and 2010 of the French Ministry of Health; PROSEVA ClinicalTrials.gov number, NCT00527813.)
Nitric oxide

Not used in adult

Increase the saturation with 5-8% but it does not impact the survival rate

Newborns with open ductus it can have a dramatically effect
Indication

Respiratory support

The traditional view of ECMO is ARDS treatment

Circulatory support

with cardiac failure  EF < 20%

ECPR

Septic shock

Trauma

ECMO is a life support tool – not a treatment
Indication

p/F ratio < 80 mm Hg

Murray score > 3 (Ceasars study)

Carbon dioxide > 100

Inotrophic index of > 50 (Minnesota)

Epinephrine + Norepinephrine > 500 ng/kg/min

And a portion of common sense, as we always have to have in our treatment.
Mean p/f ratio 1995 – 2008
Contraindication

- Complicated underlying disease
  - Bone marrow transplant
  - Late stage cancer
- HIV ?
- No limitation on time in the ventilator
The dynamics of the sepsis disease

Could be overwhelming

From emergency unit to ECMO could take 3 hours specially the patient leaking fluid into the lungs like an plasmapheresis filter.

If you are in a smaller hospital you always has to think how does this look like within the next 6-24 hours.

To transport a patient to an ECMO machine and cannulate and get on ECMO takes 12 hours ( early transportation )
Barbaro Ryan - San Diego meeting

### Predictive Ability

<table>
<thead>
<tr>
<th>SCORE</th>
<th>POPULATION</th>
<th>VARIABLES</th>
<th>ROC</th>
<th>YEARS</th>
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<td>0.74</td>
<td>2000 - 2010</td>
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# Severity of Illness Scores

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<th>SEVERITY OF ILLNESS SCORE</th>
<th>ROC</th>
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<tbody>
<tr>
<td><strong>Adult Respiratory</strong></td>
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<tr>
<td>SAPS</td>
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<tr>
<td>SOFA</td>
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<tr>
<td><strong>Adult Cardiac</strong></td>
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<td>APACHE II</td>
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<td>SOFA at ICU Admission</td>
<td>0.71</td>
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<tr>
<td>SOFA at Cannulation</td>
<td>0.79</td>
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</table>

Morin L¹, Ray S², Wilson C³, Remy S⁴, Benissa MR¹, Jansen NJ⁵, Javouhey E⁴, Peters MJ², Kneyber M⁶,⁷, De Luca D⁸, Nadel S³, Schlapbach LJ⁹,¹⁰,¹¹, Maclaren G¹²,¹³, Tissieres P¹⁴,¹⁵, ESPNIC Refractory Septic Shock Definition Taskforce the Infection Systemic Inflammation Sepsis section of ESPNIC.

Resultant bedside and computed septic shock scores had high discriminative power against the need for ECLS or death, with areas under the receiver operating characteristics curve of 0.920 (95% CI 0.89-0.94), and 0.956 (95% CI 0.93-0.97), respectively. RSS defined by a bedside score equal to or higher than 2 and a computed score equal to or higher than 3.5 was associated with a significant increase in mortality.
Don’t use scores for individual patients, use it for benchmarking

Take Home

• What we measure matters
  – what scores predict
• Current Scores are a great start, but caution should be used in applying to bedside
• Other severity of illness scores path to improvement, but
• Time in patient course when you collect data matters

Barbaro Ryan UofM
Can you be too sick to be put on ECMO

As long as you have circulation more or less everything is OK

Repeated ECHO to control the cardiac output (could be every hour)

I have put on 5 patients during the years with high inotropes, blood pressure, heart rate, half good saturation like 78%, lactate 14 (< 2) and BE -14

BUT

They had rigor mortis in the legs and arms when arrived to our ICU and a total centralized circulation
Saturation by itself is not a contraindication

Circulation is much more important than saturation

Newborns with 8, 9, 10, 11, 12 in saturation develop normal
Adults with 30-40 in saturation
Early ECMO

In the beginning we should go for p/F ratio of 80 or very high inotopic index

When you think your skill is good enough not to have mechanical complication you can wide the indication to a calculated mortality risk > 50%.

It´s very uncommon that we have mechanical catastrophic event that makes mortality

We don´t recognize better survival with early ECMO, but it´s probably safer for the patient.

We can not loose confidence from the Staff
Venoarterial Extracorporeal Membrane Oxygenation Support for Refractory Cardiovascular Dysfunction During Severe Bacterial Septic Shock*

Nicolas Bréchot, MD, PhD\textsuperscript{1}; Charles-Edouard Luyt, MD, PhD\textsuperscript{1}; Matthieu Schmidt, MD\textsuperscript{1}; Pascal Leprince, MD, PhD\textsuperscript{2}; Jean-Louis Trouillet, MD\textsuperscript{1}; Philippe Léger, MD\textsuperscript{2}; Alain Pavie, MD\textsuperscript{2}; Jean Chastre, MD\textsuperscript{1}; Alain Combes, MD, PhD\textsuperscript{1}

2008-2011
N=14
Femoral cannulation.
SAPS-3 84 (EMR 79%)
SOFA 18 (EMR>80%)

71% survived to discharge
<table>
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<tr>
<th>Age</th>
<th>Sex</th>
<th>Diagnos</th>
<th>Diagnos</th>
<th>VV/VA</th>
<th>CVVHDF</th>
<th>ECMO-dygn</th>
<th>Dead</th>
<th>Dead out of hospital</th>
<th>SAPS 3</th>
<th>EMR</th>
<th>SOFA</th>
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<td></td>
<td>9</td>
<td>14%</td>
<td>14%</td>
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Sepsis 2012  14 pat – 12 survivals
Stockholm experience
Local database 2012-2014

**SEPTIC SHOCK** (in process to be published)

Septic shock + Vasoactive Inotropic Score (VIS) = 108 (52-215)

N= 22; 14 men, 8 women

former "healthy": 8

"Organ systems" affected (max 9): 6.5 (2-8)

CPR before ECMO: 5/22

SAPS 3: 88.4 (70-112); EMR 83%

SOFA: 16.4 (14-19); EMR >80%

Survival hospital 86%  NNT 1.4

Survival >12 months 73%  NNT 1.6
Septic shock with cardiogenic shock
Awake patients
26 years pregnant women (week 26) - Scotland H1N1

Swine-flu with pneumococci pneumonia
Healthy
10 days of ventilation high pressure settings
Subcutaneous emphysema
After one week: delivery activity every second minute in two days 600 ml blood loss
If she was going to open up 3 cm the delivery team has to be washed and ready for a fast hysterectomies if it was necessary
22 days on V-V ECMO
Survivor - delivered a healthy baby 8 weeks later
The Scottish 26-year-old pregnant woman delivered 8 weeks later.
The Lungs

Consolidated stiff lungs totally occupied with cells
It’s not possible to force them to open up
No need for high PEEP with a dry patient
No need for high Peak pressure
No HFOV
The lungs will not open up until nearly all the cells is gone
The elasticity is very low for several month, and the recovery phase takes up to one year.
Pneumonia with destroyed lung structure
Red hepatisation macro
Red hepatisation micro
Tidal volume 53 days on ECMO
Hemophilus Influenza pneumonia
Infection with cellular infiltrate in the interstitium of the lung

The typical recovery of the tidal volume
The dynamic process

Total lung capacity relatively normal values after ALL with PCP pneumonia

Lindén et al.
Hemorrhagic Necrotizing Pneumonia
Staff aureus med PVL  70/230 positiv
5 years later
Longrun ECMO

Today´s longest ECMO survival and home with her own lungs is a burn patient in Baltimore 600 days on ECMO

Prolonged Duration ECMO for ARDS: Futility, Native Lung Recovery, or Transplantation?

Andrew A. Rosenberg,* Jonathan W. Haft,† Robert Bartlett,‡ Theodore J. Iwashyna,§ Steven K. Huang,§ William R. Lynch,¶ and Lena M. Napolitano*

transplantation. The lung may have unexpected regenerative capacity with native lung recovery after prolonged mechanical support, similar to acute kidney injury and native renal recovery. We recommend redefining irreversible lung injury and futility in ECMO in the context of an organized evidence-based data collection.
Mike Hines
Houston 41 patients

*In the absence of Pre-existing Lung Disease or abnormality, NO patient died due to failure of their lungs to recover...

*All patients who died due to failure of their lungs to recover, had some pre-existing lung condition (SLE, Behcet’s, Radiation Fibrosis, Unclassified Collagen Vascular Disease, or COPD/CA/PHTN)

*Patients with normal lungs prior to their “ARDS event” who subsequently expired, died of NON-pulmonary etiologies, frequently related to the same event that caused the ARDS (shock, CPR, profound hypoxemia) or sepsis.
The underlying disease

Is the only thing that matters

Decide the outcome

If we can keep the infections under control

Be awake

Wait for the recover without doing harm
Leucemia & BMT

[Bar chart showing the number of patients in different categories: ALL, AML, BMT. The chart indicates the number of surviving patients in each category.]
Association of hospital-level volume of extracorporeal membrane oxygenation cases and mortality. Analysis of the extracorporeal life support organization registry.

Barbaro RP¹, Odetola FO, Kidwell KM, Paden ML, Bartlett RH, Davis MM, Annich GM.

MEASUREMENTS AND MAIN RESULTS: From 1989 to 2013, a total of 290 centers provided ECMO support to 56,222 patients (30,909 neonates, 14,725 children, and 10,588 adults). Annual ECMO mortality rates varied widely across ECMO centers: the interquartile range was 18-50% for neonates, 25-66% for pediatrics, and 33-92% for adults. For 1989-2013, higher age group-specific ECMO volume was associated with lower odds of ECMO mortality for neonates and adults but not for pediatric cases. In 2008-2013, the volume-outcome association remained statistically significant only among adults. Patients receiving ECMO at hospitals with more than 30 adult annual ECMO cases had significantly lower odds of mortality (adjusted odds ratio, 0.61; 95% confidence interval, 0.46-0.80) compared with adults receiving ECMO at hospitals with less than six annual cases.
Future
start to plan already today

Most ECMO will start in the emergency room or the cath-lab

Cannulation doctor for heart problem will be the

- Emergency doctor
- Cardiologist

Then call the ECMO team immediately to come and pick up the patient

Cannulation doctor for ARDS will be the intensivist
In conclusion

Antibiotics – Antibiotics - Antibiotics

Early CT scan and repeated ECHO, several times per day

Recruit and try proning within the first 3 days

Ventilator settings optimal (What that is in this situation)

High Inotrops could many times be decreased with ECMO and the lactate comes down

A plain loss of SVR without oxygen consumption is hard to treat with ECMO (It’s a block on cellular level)

WHAT IS SAFEST FOR THE PATIENT

You can withdraw ECMO within hours if you don’t need it
Thank you

Keep up the spirit
Be Careful
Don’t make unnecessary action
Drink Coffee, keeps you from doing harm

Palle