ARDS in multiple trauma

- lung contusion
- massive transfusion
- aspiration of gastric content
- inflammatory mediator release
- lung collapse, atelectasis
- injurious ventilation
- infection/sepsis
Lung injury in trauma

Intubated patients
N = 621

- P:F > 300
N = 226 (36%)

- P:F ≤ 300
N = 395 (64%)

P:F ≤ 300, no ARDS
N = 212 (34%)

ARDS
N = 183 (30%)

in-hospital mortality
14% 27% 35%
Extracorporeal lung support in trauma patients

- hemodynamics?
- bleeding/anticoagulation?
- transport/surgery/diagnostics?
Traumatic lung injury treated by extracorporeal membrane oxygenation (ECMO)

J.A. Cordell-Smith\textsuperscript{a,b,*}, N. Roberts\textsuperscript{a,c}, G.J. Peek\textsuperscript{a}, R.K. Firmin\textsuperscript{a}

Table 1: Injury pattern and survival with ECMO

<table>
<thead>
<tr>
<th>Predominant Injuries</th>
<th>Number of patients</th>
<th>Survivors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long bone fracture</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Blunt chest trauma</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Combined long bone/chest trauma</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Combined pelvic/long bone fracture</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Combined chest trauma and long bone/pelvic fracture</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2: Study population characteristics

<table>
<thead>
<tr>
<th></th>
<th>Entire cohort (mean)</th>
<th>Survivors (mean)</th>
<th>Non-survivors (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>27</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>ECMO duration (h)</td>
<td>141</td>
<td>139</td>
<td>148</td>
</tr>
<tr>
<td>Murray lung injury score</td>
<td>3.1</td>
<td>3.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Injury severity score (ISS)</td>
<td>18</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>Pre-ECMO intubation time (h)</td>
<td>69</td>
<td>61</td>
<td>87</td>
</tr>
<tr>
<td>Oxygenation index ((\text{PaO}_2/\text{FiO}_2) ratio)</td>
<td>62</td>
<td>62</td>
<td>60</td>
</tr>
</tbody>
</table>

Conclusion: A high proportion of trauma patients treated with ECMO for severe lung injury survived. This outcome appears to compare favourably to conventional ventilation techniques and may have a role in patients who develop acute severe respiratory distress associated with trauma.
Extracorporeal membrane oxygenation in severe trauma patients with bleeding shock

Matthias Arlt*, Alois Philipp, Sabine Voelkel, Leopold Rupprecht, Thomas Mueller, Michael Hilker, Bernhard M. Graf, Christof Schmid

University Hospital Regensburg, Germany

PaO$_2$/FIO$_2$ = 47 (36–90)
PaCO$_2$ = 67 (36–89)
NOR = 3.0 (1.0 – 13.5) mg/h
10 multitrauma patients:
- car-motorcycle-truck crash, suicide fall
- Injury Severity Score (mean) 61

treatment on ECMO:
- damage control surgery, chest surgery
- laparotomy
- CT-scan
- kinetic therapy

blood transfusion on ECMO: 17.5 PRBC, 25 FFP

outcome: survival 6/10 = 60%
52 patients:

ISS = 59 ± 10

age = 32 ± 14

vv-ECMO = 26

pECLA = 26
ECMO-related complications in trauma patients

cannula-related 15 %
  - pECLA 19 %
  - vvECMO 12 %

abdominal bleeding in 12 pts

thoracic surgical interventions in 8 pts

mean PRBC-transfusion = 3

mean ECMO-support = 6,9 ± 3.6 days

hospital survival rate = 79 %
  (ISS-related survival rate = 59 %)

Ried, Crit Care 2013
ECMO in trauma patients: problems/practical aspects

- coagulation support
- prefer vv-cannulation
- avoid heparin 24 hrs
- start low-dose heparin > 24 hrs
- initiate lung protective ventilation
- miniaturized systems:
  - easy transport for diagnostics
coagulation management in trauma-ECMO: a fragile balance

anticoagulation
- thrombosis
- clotting
- embolus
- ischemia

coagulation:
- prevention of bleeding
- cannulae
- cerebro-vascular
- retroperitoneal
21-year old male:
- car accident
- submersion
- ARDS
- no-anticoagulation for 48 hrs
Pumpless Extracorporeal Lung Assist (Pecla) in Patients With Acute Respiratory Distress Syndrome and Severe Brain Injury

Thomas Bein, MD, PhD; Markus N Scherer, MD; Alois Philipp, ECCP; Frank Weber, MD; and Chris Woertgen, MD, PhD

2005;58: 1294
Decreasing incidence of post-traumatic ARDS: potential role of ECMO for lung protection?

ARDS and peak inspiratory pressure

D Plurad, J Trauma, 2007; 63:1
extracorporeal lung support in trauma: interdisciplinarity!

- Anesthesiologist
- Cardiovascular/thoracic surgeon
- fast Lab
- Blood bank
- Neurosurgeon
- Perfusionist
- Trauma Surgeon
- Radiologist (interventional!)
From Baghdad to Germany: Use of a New Pumpless Extracorporeal Lung Assist System in Two Severely Injured US Soldiers

MARKUS ZIMMERMANN, * ALOIS PHILIPP, † FRANZ-XAVER SCHMID, † WARREN DORLAC, † MATTHIAS ARLT, * AND THOMAS BEIN*
Prone position during ECMO is safe and improves oxygenation

PaO$_2$/FIO$_2$ > 80 + pH < 7.2

stability or low dose vasoconstrictor

PaO$_2$/FIO$_2$ < 80

instability

optimized management ≥ 6 hrs

trauma + ARDS

ECMO

stability or low dose vasoconstrictor = vv-ECMO

instability or high dose Vasoconstrictor = va-ECMO

pumpless iLA
ECMO can be used as a rescue therapy in trauma patients with severe hypoxemic respiratory failure or uncontrolled hypercapnia/acidosis - even in the presence of brain injury and/or coagulopathy.
Summary II

- trauma center and experience
- indications, contra-indications, technique
- management: device, anticoagulation, surgery, ventilation, ICU-support
- may help improve outcome!