ECMO for respiratory failure: patient selection, surgical approach, and patient management

Optimal therapies for thoracic organ failure.
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Indications and patient selection ... **application** of ECMO

... why do you want to do this ... what do you hope to achieve

*Cannulation and logistics ... **deployment** of ECMO*

... how do we do it ... when do we try

*Clinical management ... bridging to **decision, recovery, or transplant***
Clinical indications for extracorporeal gas exchange...

- hypercarbia
- hypoxia
- pulmonary vascular
- airway loss

ventilatory failure
respiratory failure
pump failure
ECMO/ECLS institutional demographics

- Graft dysfunction/post heart tx: 3%
- OSH: 5%
- IPPH/RV failure: 13%
- ILD/hypoxia: 10%
- ILD/PHTN: 15%
- LV failure: 12%
- Thromboembolic: 3%
- Pneumonia/H1N1: 13%
- Portopulm HTN: 4%
- Tracheal/airway: 11%
- Post-cardiotomy: 4%

100 sequential deployments
Patient selection

No lung injury benefits from paralysis, sedation, mechanical intubation, and non-physiologic positive pressure ventilation

Medical futility is not an indication for surgical intervention

“failure to rescue” metrics are the only QAPI measures of consequence

Patient management

The addition of extracorporeal technologies to a mechanically ventilated patient increases morbidity ... avoid or limit anticoagulation, extubate early

Patients with cardiopulmonary failure who are upright, ambulatory, and socially interactive have improved outcomes

Have an exit strategy ...
“rules” for deployment...

Deployment of ECMO technologies in the context of medical futility generally results in futile deployment of technology...it is rarely “the device”

ECMO technology generally restores physiology but may not alter survival depending upon the specifics of deployment (timing and strategy)

ECMO can support patients awaiting good clinical decision making ... it is ineffective in supporting bad clinical decisions

Effective MCS is an awake, extubated, and ambulatory patient
Extracorporeal Membrane Oxygenation for Acute Respiratory Failure in Adults: The Need for Pulmonary INTERMACS

... we disagree with the consensus statement that “optimization of conventional treatments ... should always be undertaken prior to considering ECMO in patients with severe acute respiratory distress syndrome (ARDS).”

“A consensus statement that recommends the sequential deployment of extracorporeal technologies after established therapies promulgates the traditional bias that ECMO is “salvage therapy” for patients with disease refractory to medical therapy”

Oxygenation index (OI): mean airway pressure, FiO2/PaO2 ratios (“40”)

ELSO: “considered” at 50% mortality, “indicated” at 80% mortality
Respiratory failure
pAO2 < 60, pCO2 > 60
pH < 7.20 on MV

"moratorium of decision",
unstable hemodynamics or
ECMO transport

VA ECMO (femoral)
(<72 hrs, wean sedation
and pressors, trach)

"awake", nl ECHO
or
abnl ECHO (cor pulmonale)

PECLA triage (pumpless femoral AV ECMO)

"unstable"
"stable"

VAV (DLC/subclavian a.)

VV DLC +/- BAS

RA to PA or
PA to LA

RA to Ao

"Ambulatory ECMO bridge"

"Awake, non-ambulatory
ECMO bridge"
Non physiologic and inherently unstable ... retrograde arterial flow

Efficacy proportional to LVEF

Distal malperfusion ...

The patient ... non-ambulatory
23 yo female cystic fibrosis transferred
intubated with uncontrolled BPF...
pH 7.27, PCO2 105, PaO2 42...
thoracostomy tube in place w/o
re-expansion

Venovenous DLC ECMO (Avalon)... w/drawl positive pressure ventilation
Resolution of BPF, re-expansion... ECMO day 10

Ambulating on DLC ECMO... to transplant
Approaches to *cor pulmonale* and right ventricular failure
Two atrial septal punctures were performed under ICE guidance, one along the limbus of the fossa ovalis and one inferiorly and anteriorly. Two SLO transseptal sheaths were placed in the left atrium and the blade septostomy performed with cuts oriented toward the central portion of the fossa ovalis. The two septostomy cuts were connected with a 20 mm balloon dilatation. Adequacy of the septostomy was confirmed by ICE imaging, with large volume right-to-left flow and a broad color flow jet. With significant right to left shunt the peripheral O2 saturation dropped abruptly to 70 - 74%.

A 27-French Avalon dual lumen veno-venous ECMO cannula was inserted over the previously placed wire and the catheter was pulled into position from below. The ECMO circuit was connected and flows advanced to 3.5 L/min with immediate increase in systemic O2 saturation (>94%). Contrast angiography was performed by injecting the venous return limb of the ECMO circuit. Using contrast return as guidance, the cannula was positioned to optimize right-to-left flow.
Veno-venoarterial (VVA) “hybrid” ECMO

antegrade flow … mixed cardiopulmonary disease

“hybrid” VVA, or full VV, or full VA
(27Fr DLC/15Fr EOPA…50:50 flow)

support technology … not salvage

ambulatory
An ambulatory percutaneous oxyRVAD ... Protek DUO

PHTN s/p PEA, 52 days to BLTx

not a salvage technology ...
The central “oxyRVAD”...

centrifugal pump
10 mm Dacron PA inflow graft
28 angled RA outflow
Central cannulation ... Thoratec CentriMag RVAD
“pulmonary bypass”...

supra-systemic pulmonary pressures do not require a centrifugal pump ... Pumpless ExtraCorporea Lung Assist (PECLA)
Complex adult congenital... pulmonary hypertension

Pulmonary Heart Failure
thromboendarterectomy

“RV rescue”

Should these patients be transplanted?

... the failing Fontan, pulmonary agenesis, DORV, old TOF, Eisenmenger's, old “Mustards”
“goal directed ECMO” ... reperfusion injury
chronic thromboembolic disease ...
Rule of 6”s ... post op lung tx
Defining irretrievable lung injury...

Nosology of ECMO bridge to transplant ... a pulmonary INTERMACS?
Prolonged support ... the 21 day exclusionary rule is dead

greater appreciation of “recovery” ...

... concern w/r to “salvage tx”

“off” day 132
Is fibroproliferative lung injury ...

an *inevitable* consequence of acute lung injury ...

a *select* response to some injury in some patients, or ...

a *consequence* of therapy?

BAL and serum biomarkers biome (micro/viral) antibody repertoire sequential microarray
What about “salvage” transplant?
ECMO bridge to transplant ...

31 patients
1 yr survival 93%
mean DOS 14 days

... no patient was vent dependent
... > 50% ambulatory, all were ‘awake”
... ~ 50% cor pulmonale, PEA

Hoopes et al, JTCVS 2013
Does the history of cardiac mechanical circulatory support inform the application of pulmonary support technologies...absolutely!

Both of these patients have an LAS of 88.9

ECMO is not the defining variable

Is it time for a pulmonary INTERMAC ... IMACS?

Cardiac
INTERMACS 1. Critical cardiogenic shock ...
INTERMACS 2. Progressive decline ...
INTERMACS 3. Stable inotrope dependent ...
INTERMACS 4. Recurrent advanced disease ...

Pulmonary
Fulminant respiratory failure
Escalating mechanical support
Ventilator dependent
Absence of pulmonary reserve