UNUSUAL INDICATIONS FOR ECMO
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DISCLOSURE
There are no conflicts of interest or relevant financial interests in making this presentation and have indicated that my presentation does not include discussion of an unlabeled use of a commercial product, or an investigational use not yet approved for any purpose.

OBJECTIVES

• Sepsis
• Massive Pulmonary Embolism
• Toxicology

ECMO IN ADULT SEPTIC SHOCK

• Bacteremia were considered relative contraindication
• Entrapping bacteria, function as culture medium
• Septic coagulopathy
• Increase risk of bleeding
• Minimal reports of use of ECMO in adult septic shock
• During last decade
• Improvement in technology
• Safety
• Indications are continuously being challenged

CASE SERIES
14 patients with severe septic shock and refractory cardiac dysfunction

- All placed fem-fem VA ECMO
- Evidence of tissue hypoxia (mottling or elevated blood lactate (average 9))
- Confirmed intravascular volume repletion
- Severely suppressed LV function 10-30% (avg 16%)
- CI < 2.2L/min/m sq (avg 1.3)
- high-dose catecholamines
- Shock to ECMO interval: 24 hours (3 to 108 hrs)

10 of 14 survived


Adult patients in refractory septic shock and requiring VA ECMO for support

- 52 patients
- 75% had failure of at least 3 organ systems
- 40% developed cardiac arrest then cannulated
- 8 of 52 (15%) survived. All 20 patients aged 60 or older died

TOO LATE


• VV septic: 45.5% survival
• VA septic: 24.4% survival
• CPR pre-ECMO 32%
• CPR during ECMO 34%

TOO LATE
• Hypodynamic/preserved LV function
• Worse outcomes on VA vs VV reported


Actual incidence of global left ventricular hypokinesia in adult septic shock

Antoine Viallard-Baron, MD; Vincent Colle, MD; Cyril Charron, MD; Guillaume Delattre, MD; Bernard Paye, MD; Francois Jardin, MD

- Septic shock patients studied by TEE
- Global LV hypokinesia defined as LV ejection <45%
- No free of cardiac disease
- 26 of 67 on admission (40%)
- Additional 14 within 24-48hrs (40%) septic patients had LV dysfunction
- Acute and reversible; providing patient recover

Circulating Myocardial Depressant Substance (MDS)

TNF-α
IL-1β
IL-6
NO

Crit Care Med 2008 Vol. 36, No. 6
MODE SELECTION: CONUNDRUMS IN ECMO

- VA ECMO is tempting to consider as a solution to all problems

- Example: respiratory failure with profound hemodynamic compromise, ongoing hypoxia despite advance mechanical ventilator settings, elevated intrathoracic pressures, worsening acidosis...

- Restoration achieved by both VA and VV

Which mode

1. Cardiogenic shock (LV <30%) and sepsis: Peripheral VA ECMO
2. ARDS and Hyperdynamic/preserved LV function: VV ECMO
   - Reduction in vasopressor requirements usually dramatic
3. Severe ARDS and depressed LV function: VA or VAV
   - Peripheral VA can result in desoxygenated blood being ejected by the LV, due to pulmonary dysfunction, minimizing appropriate oxygenation to the heart, brain and upper body
   - Central VA or VAV hybrid can be used to overcome this problem

Take away points for sepsis and ECMO

- Ideally initiate within first 24hrs of shock onset
- Confirm patient not fluid responsive
- Lactate <4.5
- SOFA score < 1.5
- LV dysfunction EF <30% will need VA vs VAV
- CPR pre-ECMO or during ECMO..........poor outcomes
- Support to LV recovery

Table 2 Incidence of LV systolic dysfunction in septic shock according to the time of evaluation

<table>
<thead>
<tr>
<th>Time of sepsis evaluation</th>
<th>Incidence of LV systolic dysfunction</th>
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<tbody>
<tr>
<td>Day 1</td>
<td>20%</td>
</tr>
<tr>
<td>72 hours</td>
<td>35%</td>
</tr>
<tr>
<td>Day 3</td>
<td></td>
</tr>
<tr>
<td>48 hours</td>
<td>15%</td>
</tr>
<tr>
<td>Day 1.5</td>
<td>60%</td>
</tr>
<tr>
<td>96 hours</td>
<td>100%</td>
</tr>
</tbody>
</table>

LV = left ventricle; TE = transeosophageal echocardiography; TTE = transthoracic echocardiography; CPR = cardiopulmonary resuscitation; EF = ejection fraction; SOFA = Sequential Organ Failure Assessment.
CASE 1
• 39 y.o. male was admitted septic shock (lactate 4.4, 3 pressors)
  • Acute respiratory failure, lobar pneumonia after a 5-day flu-like illness and acute renal failure
  • Blood and sputum cultures were positive for Beta Streptococcus Group A.
  • Echocardiogram initially showed mild decrease in LV and RV systolic function
  • 24hrs after admission showed severe biventricular systolic heart failure with LVEF < 20%
  • Evolving ARDS, Refractory hypoxia despite aggressive ventilator settings
  • What type of ECMO should be considered?

CASE 2
• 59 year old female with URI symptoms since early October treated with Augmentin and Levofloxacin
  • Presented to OSH ED- O2 sat 82%, lactate 4.6
  • On admission Cr 5.5, ABGs 7.11 /50/64/15
  • Pt intubated and started on Flolan, Norepi, vasopressin, epi and phenylephrine
  • Pt paralyzed on FI02 100% - chest CT showed consolidation bilateral upper lobes and left lower lobe
  • TTE hyperdynamic LV with EF>70%
  • Blood culture from outside hospital + strep
  • What type of ECMO mode???
ECMO IN MASSIVE PE

- AHA define massive PE as sustained hypotension (systolic BP <90 mmHg or systolic pressure drop >40mmHg for 15 min) or requiring inotropic support
- Cardiogenic shock that results from pulmonary embolus has a high mortality rate (20% -30%)
- Impending or ongoing cardiac arrest
- Systemic thrombolysis or anticoagulation alone has not been always shown to be effective

MASSIVE PE

- Treatment
  - Anticoagulation RR
  - Systemic or intrapulmonary thrombolytic (6.2% mortality)
  - Clot fragmentation, suction embolectomy (13.5% treatment failure including death)
  - Surgical embolectomy (6% 30 day mortality)
- Hemodynamically unstable patients/ cardiac arrest
- Diagnostic and therapeutic options may be limited

RV FAILURE AND ECMO

- Rationale is to divert some blood from right atrium to the arterial circulation
- Unloading the RV and relieving its dilation
- ECMO relieves hypoxemia due to shunt and can provide therapeutic means by anticoagulation
- Massive pulmonary emboli will usually resolve or move into segmental branches within 48-72 hours of ECLS support

- Reviewed case reports and case series published in last 20yrs
- 11 single case reports and 8 case series
- Definitive tx ranged from none to any thrombolytic, catheter embolectomy or surgical embolectomy

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number (%)</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>8 (73%)</td>
<td>1 (12%)</td>
</tr>
<tr>
<td>Thrombolysis</td>
<td>2 (18%)</td>
<td>1 (12%)</td>
</tr>
<tr>
<td>Catheter embolectomy</td>
<td>3 (27%)</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>Surgical embolectomy</td>
<td>2 (18%)</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>Thrombolysis + Catheter embolectomy</td>
<td>1 (9%)</td>
<td>1 (12%)</td>
</tr>
<tr>
<td>Thrombolysis + Surgical embolectomy</td>
<td>2 (18%)</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>Thrombolysis + Catheter embolectomy + Thrombolysis</td>
<td>3 (27%)</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>Total</td>
<td>20 (100%)</td>
<td>8 (40%)</td>
</tr>
</tbody>
</table>
• VA approach in 88%, VV 1.6, VAV 10.2%
• Thrombolysis part of cardiac arrest algorithm when PE suspected
  • 55% cases presenting in cardiac arrest
  • 31.2% survival
• Overall survival was 70.1% and none of the definitive treatment modalities was associated with higher mortality

<table>
<thead>
<tr>
<th>Definitive Treatment</th>
<th>Odds ratio (95% CI)</th>
<th>P-value</th>
</tr>
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<tr>
<td>Surgical embolectomy</td>
<td>3.5 (95%-13.6)</td>
<td>0.067</td>
</tr>
<tr>
<td>Thrombolysis</td>
<td>1.8 (95% - 10.0)</td>
<td>0.098</td>
</tr>
</tbody>
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Perfusion. 2015. Vol. 30(8) 611-616

• 21 patients with MPE with profound shock and severe hypoxemia treated with ECLS
• Cardiac arrest due to PE (8 cases)
• Survival rate 62%
• Six patients had fibrinolytic therapy before requiring ECLS
• 10 of the 13 survivors required no additional therapy other than anticoagulation
  • Two patients underwent surgical pulmonary embolectomy after initial ECLS
  • TEE 4 days after ECLS demonstrated minimal clot dissolution and persistent RV failure


• 193 cases: overall 73% survival (65% in cardiac arrest)
• ECMO was combined with:
  • surgical embolectomy in 35% (68 of 193)
  • thrombolytic therapy in 62% (120/193)
  • catheter therapy in 24% (46/193).
• The survival rate breakdown:
  • 80% in surgical embolectomy
  • 71% in thrombolytic therapy
  • 76% in catheter therapy


TIMING

• Bedside decision
  • Look at all factors
• Cardiac arrest
  • tPA vs no tPA
  • Percutaneous vs cutdown
• Impending arrest
  • Maintain hemodynamic stability for bridge to definitive therapy
  • Transport of patient to facility where surgical embolectomy could be feasible
• Contra-indication for tPA
TOXICOLOGY

- Calcium channel blockers and beta-blockers represent more than 65% of deaths from acute drug intoxication [1].
- Beta blocker poisoning can result in fourfold cardiovascular toxicity
  - Myocardial depression, bradycardia
  - Impairs intracellular movement of calcium into muscle cells
  - QRS widening, QT lengthening, especially with sotalol
  - Predisposes to VT, torsades de pointes, VF
  - Vasodilatation

1. F. Sangalli et al. ECMO-Extracorporeal Life Support in Adults; Springer-Verlag Italia 2014.
2. ANNALS OF EMERGENCY MEDICINE 37 : 4 APRIL 2001

RESUSCITATION

- Insulin-glucose infusion
- Calcium……a lot
- Low threshold for S-G cath
- Rapid escalation of pressors
- Methylene Blue
  - Inhibits the nitric oxide
  - Decreasing vasodilatation
  - Increasing responsiveness to vasopressors

SEQUESTRATION THERAPY

- Fat emulsions (Intralipid® 20%) only for patients in extremis and not responding to other resuscitative measures……..
  - bolus doses of 1.5 mL/kg over 1 minute,
  - infusion of 0.25 mL/kg/min

FIRST REPORTED SERIES

- Babatasi et al. 2001
- Six patient with cardiac arrest following intentional overdose of beta-blockers, calcium channel blockers
- Supported on fem-fem VA ECMO
- First two patients died of MSOF due to delay in installation
- Four patients survived without neuro or medical sequelae
• Largest case series to date
  • 721 patients admitted for drug intoxication, 17 with refractory cardiogenic shock (n=10) or cardiac arrest (n=7)
  • All fem-fem VA ECMO
  • 13 survived and were discharged without significant cardiovascular or neurological sequelae

Daubin et al. Critical Care 2009, 13:R138

• compared poisoned cardiogenic shock patients treated with or without ECLS
  • 10 persistent cardiac arrest and 42 with severe shock
  • 14 patients were treated with ECLS and 48 patients with conventional therapies
  • 12/14 ECLS survived, including all cardiac arrest


CASE 1
• 61 year old gentleman who has been having multiple psychosocial stressors
  • Month supply metoprolol and norvasc
  • Felt somewhat dizzy, nauseated.
  • Emergency Department at 8 hours after ingestion
  • Dopamine>norepi> High dose insulin> methylblue
  • TTE preserved LV function, HR >65
  • 26 hrs after ingestion: worsening shock, on/off epi, SG placed
  • Temp pacer as HR into 40s
  • Emergent ECMO
  • 73 hr. run time and successful decanulated

CASE 2
• 65 year old female found by her husband after having taken a month's worth of atenolol and a “handful of ambien”.
  • She was awake and talking when husband first arrived at home. Reported atenolol at 5 pm followed by ambien at 10 pm.
  • Unresponsive in the ambulance and was intubated at OSH.
  • 4hrs in the ED before developed hypotensive and bradydysrhythmia responded to dopamine
  • Delay in transfer due to weather
  • Escalating multiple amps of epinephrine, and high dose epinephrine and norepinephrine infusions, and vasopressin.
  • Worsening metabolic acidosis (Lactate 9.4), acute kidney injury.
  • Bradycardia into 40s. Urgently taken to cath lab for transvenous pacing after transcutaneous pacing failed to capture.
  • Heart rate 100 (paced), Pa pressure 40/28 PCW 28 TD CO 2.47 CI 1.61 MVO2 48%
  • Methylene blue given with improvement in SVR
  • Discussions regarding intralipid
  • STAT echocardiogram reveals globally depressed EF with apical ballooning wall motion abnormality pattern consistent with a takotsubo cardiomyopathy.
  • VA ECMO remained as the best salvage therapy for her ongoing shock
CONSENSUS

- Earlier the better, delay of shock presentation given slow absorption
- Intralipid not good for circuit
- IABP plays a role in less severe forms
- ECMO is crucial with severe cardiogenic shock
  - Gain time to recovery / washout
- Average ECMO duration 4.5 days; thus lower chance complications
- Drug poisoning appears to be one of the most favorable scenarios for ECMO support

THANK YOU

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