Mechanical Support of the Right Ventricle in Children with Pulmonary Hypertensive Vascular Disease

6th International Conference
Neonatal & Childhood Pulmonary Vascular Disease
San Francisco, California
June 21-22, 2013

Ivan M. Rebeyka, M.D.
University of Alberta
& Stollery Children's Hospitals
Edmonton, Alberta, Canada

Disclosures

No conflicts to disclose
LVAD Support as a Bridge to Transplant in Patients with Heart Failure Complicated by Pulmonary Hypertension

"Unloading of the LV via LVAD support can improve pulmonary hemodynamics and improve candidacy for transplantation."

Heart transplant listing criteria

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Transplant Mortality</th>
<th>PVR (WU/M²)</th>
<th>Transpulmonary Gradient (TPG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk</td>
<td>&lt; 5%</td>
<td>&lt; 4</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Medium Risk</td>
<td>10%</td>
<td>4 - 6</td>
<td>10 - 15</td>
</tr>
<tr>
<td>High risk</td>
<td>20%</td>
<td>&gt; 6</td>
<td>&gt; 15</td>
</tr>
</tbody>
</table>
LVAD support in patients with end-stage heart failure and pulmonary hypertension

- Improves pulmonary hemodynamics
- Improvement in PVR/TPG usually occurs early and is sustained
- Is associated with acceptable risk
- Independent of device type
- ?? Should be considered in all cardiac transplant candidates previously considered to have irreversible pulmonary hypertension

Mechanical Circulatory Support Options for Pulmonary Hypertension

1. Extracorporeal Membrane Oxygenation (ECMO)
2. Right Atrium to Pulmonary Artery (classical RVAD)
3. Pulmonary Artery to Left atrium (with Novalung)
4. Right Atrium to Aorta (with pump and oxygenator)
Pediatric Mechanical Circulatory Support

Emergency support
   (ECMO)

Short-term support
   ("Bridge to Decision device")

Long-term support
   (Implantable VAD)

Short-term VAD vs Implantable VAD

CentriMag
   $5,000.00

HeartWare
   $100,000.00

Mechanical Circulatory Support Options for Pulmonary Hypertension

1. Extracorporeal Membrane Oxygenation (ECMO)
2. Right Atrium to Pulmonary Artery (classical RVAD)
3. Pulmonary Artery to Left atrium (with Novalung)
4. Right Atrium to Aorta (with pump and oxygenator)

Extra Corporeal Membrane Oxygenation (ECMO)
ECMO Complications

- Bleeding, Bleeding, Bleeding
- Neurological injury
- Lung / liver / renal dysfunction
- LV not decompressed

Mechanical Circulatory Support Options for Pulmonary Hypertension

1. Extracorporeal Membrane Oxygenation (ECMO)
2. Right Atrium to Pulmonary Artery (classical RVAD)
3. Pulmonary Artery to Left atrium (with Novalung)
4. Right Atrium to Aorta (with pump and oxygenator)

RVAD / LVAD Support

**RVAD**
- Inflow - RA
- Outflow - PA

**LVAD**
- Inflow - LA
- Outflow - Aorta

Mechanical Circulatory Support Options for Pulmonary Hypertension

1. Extracorporeal Membrane Oxygenation (ECMO)
2. Right Atrium to Pulmonary Artery (classical RVAD)
3. Pulmonary Artery to Left atrium (with Novalung)
4. Right Atrium to Aorta (with pump and oxygenator)
Mechanical Circulatory Support Options for Pulmonary Hypertension

1. Extracorporeal Membrane Oxygenation (ECMO)
2. Right Atrium to Pulmonary Artery (classical RVAD)
3. Pulmonary Artery to Left atrium (with Novalung)
4. Right Atrium to Aorta (with pump and oxygenator)

PA - LA Novalung Assist

Novalung vs Quadrox

<table>
<thead>
<tr>
<th></th>
<th>Novalung</th>
<th>Quadrox</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polymethylpentine (PMP)</td>
<td>Polymethylpentine (PMP)</td>
<td></td>
</tr>
<tr>
<td>Low resistance</td>
<td>High resistance</td>
<td></td>
</tr>
<tr>
<td>No pump needed</td>
<td>Pump required</td>
<td></td>
</tr>
<tr>
<td>Good CO2 clearance</td>
<td>Good CO2 clearance</td>
<td></td>
</tr>
<tr>
<td>Poor oxygen transfer</td>
<td>Good oxygen transfer</td>
<td></td>
</tr>
</tbody>
</table>
Mechanical Circulatory Support Options for Pulmonary Hypertension

1. Extracorporeal Membrane Oxygenation (ECMO)
2. Right Atrium to Pulmonary Artery (classical RVAD)
3. Pulmonary Artery to Left atrium (with Novalung)
4. Right Atrium to Aorta (with pump and oxygenator)

**RVAD / LVAD Support**

**RVAD**
- Inflow - RA
- Outflow - PA

**LVAD**
- Inflow - LA
- Outflow - Aorta

**PA – LA cannulation (with Novalung)**

Pros
- better RV unloading
- simpler circuit (no pump)

Cons
- thromboembolism risk (especially in children)
- requires good RV / LV function
- flow not adjustable
RA – Aortic cannulation (with pump and oxygenator)

Pros
- not dependent on RV / LV function
- flow adjustable (CentriMag)
- better oxygenation (Quadrox)
- stable cannulae for patient mobilization

Cons
- less RV unloading

Salvage Cardiectomy

Goretx graft to aorta
Gelweave graft to left atrial cuff
Berlin Heart cannulae

Salvage Cardiectomy

Aortic cannula
Atrial cannula
Salvage Cardiectomy

Aortic cannula

Atrial cannula

Saline bag filler

CentriMag support following total excision of heart

Thank you for your attention