Mechanical Circulatory Support in High Risk Children: Who Benefits?

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Mechanical Circulatory Support in High Risk Children: Who Benefits?

- Acutely Decompensated Heart Failure?
  - Acute Heart Failure
    - Myocardiditis
    - Post Cardiotomy
  - First presentation of chronic heart failure
  - Acute recurrent presentation of chronic heart failure
  - Cardiac Arrest

- Who Benefits?
  - the patient?
  - Which organs?
  - the physicians?

- What is high risk?
  - Risks posed by comorbidities including current patient status
  - Risks of complications from mechanical support
Mechanical Circulatory Support Who Doesn’t Benefit?

- Those that don’t need mechanical support obviously don’t benefit
  - Medical Management
- Those that develop complications may or may not have benefited
- Those that need mechanical support but didn’t need a big hole in their ventricle in order to receive it
  - ECMO or Temporary Support vs Ventricular Assist Device
- Those in which the risks outweigh benefits
  - Prohibitive risk of significant complication
  - Congenital Heart Disease?
- Those that died waiting on a decision about whether or not they needed mechanical support
Who Does or Does Not Need Mechanical Support?

I shall not attempt further to define the kinds of material I understand to be excluded from that shorthand (photography), and perhaps I am intelligibly doing so.

The difference between pornography and erotica is lighting.

— Gloria Leonard —
Who Doesn’t Need Mechanical Support?

- No to minimal inotrope support
  - Two inotropes?
  - Need for ANY Adrenoceptor agonist?
  - Escalating Dose of Inotropes?
- Not requiring mechanical ventilation
- Those tolerating oral intake
- Those without arrythmias
- Those without evidence of worsening end organ function

Ultimately it’s the “gestalt” of the care team
- Tolerance for risk and ability to recover
- Congenital Heart Disease, shunts, single ventricles
- Complication profile for that particular institution
- Blood type, “getting calls, not getting calls”
7 children at previously “aggressive” MCS institution

Treated with Levosimendan, Milrinone, Nesiritide

No need for MCS

that mainly the combination of levosimendan and milrinone was very effective. We also added nesiritide in most patients, and no adverse effects were observed.

After a very successful series of patients treated with MCS, we were able to redefine our indications for MCS. Five years earlier, we defined our criteria for MCS as FS (10% or less), EF (20% or less), and imminent MOF. From our experience described earlier, we feel that MCS should be initiated exclusively in cases with progressive MOF or where respirator weaning has failed.
Who Doesn’t Benefit from Mechanical Support

- Those that develop significant complications
  - Bleeding
  - Thromboembolism
  - Risk of surgery

- Neck Cannulation vs Central Cannulation

- Closed chest vs. open chest
  - Coring lesion of the ventricle, and ease or difficulty of device extraction are risks if the patient recovers
  - ECMO creates afterload on the already failing myocardium

- Inadequate left ventricular decompression
  - No benefit (to the heart, or lungs) may benefit other organs

- Those that arrest before receiving support
  - Generally worse outcomes
  - Risk of neurologic injury

- Those with no reasonable prospect of recovery or transplantation
Decision Algorithm

Pediatric Mechanical Circulatory Support

Infant/neonate requiring MCS → Type of support needed → Cardiac only

Cardio-pulmonary support i.e., arrest, unable to ventilate → ECMO

Cardiac assist device → Pulmonary recovery

< 2 wk recovery expected?

Yes

Acute process
- Myocarditis
- Acute graft rejection
- Unknown status

Short-term VAD
- Rotaflow
- PediMag/Tandem Heart
  (BSA<1.3)
  (BSA>1.3)

Recovery

Bridge to decision

Bridge to bridge

No

Chronic process
- DCM
- End-stage CHD

Long-term VAD
- EXCOR
- HeartMate II
  (BSA<1.3)
  (BSA>1.3)

Heart transplant

Destination

Recovery

Currently not an option

Fig. 1. Protocol for device selection; name of the devices used in the figure are authors’ preference for each device type.
ADHF: Failed Medical Management

Post Cardiotomy

Cardiac Arrest

“New” Presentation

Worsening Chronic HF

Cath Lab or OR

ECMO

Likely to recover < 1 mos?

YES

“No Long Term ECMO” or “Temporary VAD” Æ Insure adequate LV decompression

NO

Ventricular Assist Device
SEVERE LEFT VENTRICULAR DYSFUNCTION AND LEFT ATRIAL HYPERTENSION
ECMO

- LEFT ATRIAL VENTING
- BALLON ATRIAL SEPTOSTOMY
Short- and intermediate-term survival after extracorporeal membrane oxygenation in children with cardiac disease

Constantinos Chrysostomou, MD, a Victor O. Morell, MD, b Bradley A. Kuch, BS, RRT-NPS, FAARC, a Elizabeth O’Malley, CCP, LP, b Ricardo Munoz, MD, a and Peter D. Wearden, MD b
Recovery & Survival

28 day Survival – 78%
Hospital Survival – 76%
ECPR Survival – 75%

N = 98 (102 runs)

Avg Duration 65 hours (32-113)
# Pumps

<table>
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<tr>
<th>Class</th>
<th>Roller (3/8”)</th>
<th>BP-80</th>
<th>Revolution</th>
<th>RotaFlow</th>
<th>CardioHelp</th>
<th>DeltaStream</th>
<th>CentriMag</th>
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<td>Max RPM</td>
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<td>3,500</td>
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<td>10,000</td>
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<td>Max Flow (L/min)</td>
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<td>6</td>
<td>8</td>
<td>10</td>
<td>7</td>
<td>8</td>
<td>10</td>
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<tr>
<td>Max Outlet Pressure (mmHg)</td>
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<td>NIH (g/100L)</td>
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<td>0.061</td>
<td>0.034</td>
<td>0.033</td>
<td>NA</td>
<td>NA</td>
<td>0.003</td>
<td>0.015</td>
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**ONLY ¼” Centrifugal Pump**
Better Oxygenators

• Switch to hollow fiber membrane oxygenators from silicone membrane oxygenators and from polypentene to polymethylpentene
  ✐ Superior gas exchange
  ✐ Decreased resistance to centrifugal pumps
  ✐ Decreased prime
  ✐ Decreased RBC, platelet and plasma consumption / damage
Paracorporeal Centrifugal VAD support
Taken to OR placed on PediMag pump Right and Left Heart Support + Oxygenator

- 14 French Right Atrial Cannula
- 12 French Left Atrial Cannula
- PediMag Pump
- Oxygenator
- 8 French Arterial Cannula

*Tunneled Left Atrial Cannula and aortic cannula, chest left open for exit of R atrial cannula
5 days later

12 French Left Atrial Cannula → PediMag Pump → 8 French Arterial Cannula

Chest closed, supported for 5 weeks, extubated, successfully transplanted and discharged
ADHF: Failed Medical Management

Post Cardiotomy

Cardiac Arrest

“New” Presentation

Worsening Chronic HF

Cath Lab or OR

ECMO

 Likely to recover < 1 mos?

YES

NO

“Long Term ECMO” or Temporary VAD

Ensure adequate LV decompression

Ventricular Assist Device
Who Benefits?

The argument can be made that every child who **NEEDS MCS** should receive at least some type of "easily" applied temporary support

- Bridge to Decision
  - No patient truly “too high” risk, few absolute contraindications, some may be clearly futile

The doctor benefits

- Patient more stable
- Need to avoid complications

Which organs benefit

- Improved oxygen delivery clearly benefits end organs
- Less catecholamine stimulation benefits the heart AND other organs
- Need to avoid complications