Cardiogenic Shock + Critical Aortic Stenosis = Run the Other Way?!!

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Severe Aortic Stenosis and Onset of Symptoms

Onset of dyspnea and other heart failure symptoms foretell the worst outlook for AS patients¹

Classic symptoms of AS:
- Angina
- Syncope
- Heart failure

¹Carabello BA, Paulus WJ. *Lancet* 2009; 373: 956-66
Case Study

- 97yo female transferred from OHP for BAV/TAVR evaluation
  - PMHx: HTN, CHF
  - Outside ICU with CHF exacerbation, declined over 2-day period requiring intubation (versed drip)
  - Hemodynamically stable (90-100/50s) but on 100% FiO2
    - ? MS changes but Head CT negative
    - Rx for HCAP
  - Outside echo EF 50%, AVA 0.5cm2
  - “Oh yeah...pt is a DNR CCA but changed code status this morning”.....
Case Study

- Repeat echo at OSU
  - EF 26%
  - Mild RV dysfunction
  - Moderate-severe MR
  - Severe Aortic Valve Calcification
    - Mean gradient 67 mmHg, peak 108 mmHg
    - AVA 0.33 cm²
  - Moderate PHTN, RVSP 57 mm Hg
- Patient has rapid decline upon admission
  - BP 70/40 on 20 mcg/min dopamine, hypoperfusing
  - TAVR Consult Team called for Stat Consult
Palliative Care

Severe AS+ Cardiogenic Shock

Medical Therapy

Mechanical Therapy
Medical Therapy

- **Nitroprusside**
  - **Inclusion:**
    - ICU admission w CHF; Severe AS (< 1 cm²); EF ≤35%; CI <2.2 L/min/m²
  - **Exclusion:**
    - Hypotension requiring inotropic or pressor support or MAP < 60 mmHg

- **Dobutamine**
  - Predominantly β₁ (inotrope/chronotrope)
  - Minimal and β₂; results in vasodilation (decreased SVR)

- **Dopamine**
  - Low dose; dopamine-1 receptors (selective vasodilation renal/mesenteric/cors)
  - 5-10mcg/kg/min; β₁(inotrope/chronotrope)
  - >10 mcg/kg/min; ↑α (vasoconstrictor)

- **Norepinepherine**
  - β₁,α₁ (potent vasoconstrictor, modest increase CO)

- **Phenylepherine**
  - α agonist (pure vasoconstrictor, minimal cardiac inotropy/chronotropy)

Khot, UN et al; N Engl J Med 2003; 348:1756-1763
Palliative Measures

- Protocol development for Palliative Care Consults on critically ill AS patients undergoing evaluation for TAVR
- Palliative Care Consult on all patients in Cardiogenic Shock
  - Address goals of care for patient and family
  - Address advanced mechanical options
    - Identify true risk of procedures
  - End-of-life discussions
Mechanical Therapy

- Mostly Case Reports
  - Lack of evidence based therapies
- Limited, small, non-randomized analysis
- Device options
  - CPB/ECMO
  - Tandem Heart
  - Impella
  - IABP
  - Others?
Percutaneous Balloon Aortic Valvuloplasty

- Indications
  - Bridge to surgery in hemodynamically unstable patients
  - Palliation
  - Bridge to surgery in symptomatic pregnant patients
  - Patients requiring noncardiac surgery – however, guidelines indicate asymptomatic patients with severe AS should proceed to surgery without BAV
  - Bridge to SAVR
  - 83% of Med Mgmnt Pts in PARTNER A
Percutaneous Balloon Aortic Valvuloplasty: Pre-TAVR data, an acceptable medical therapy?

Echocardiographic Data on the 187 Patients Before and After Balloon Aortic Valvuloplasty and at 6-Month Follow-up

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Baseline</th>
<th>After Valvuloplasty</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS-Jet Vmax, m/s</td>
<td>155</td>
<td>4.4±0.7</td>
<td>3.9±0.7*</td>
<td>4.1±0.6t</td>
</tr>
<tr>
<td>Mean ∆P, mmHg</td>
<td>157</td>
<td>49±16</td>
<td>38±14*</td>
<td>43±15t</td>
</tr>
<tr>
<td>AVA, cm²</td>
<td>115</td>
<td>0.57±0.21</td>
<td>0.78±0.31*</td>
<td>0.65±25t</td>
</tr>
<tr>
<td>Aortic regurgitation</td>
<td>176</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>44</td>
<td>(25%)</td>
<td>36 (21%)§</td>
<td>32 (18%)t</td>
</tr>
<tr>
<td>Mild</td>
<td>101</td>
<td>(57%)</td>
<td>99 (56%)</td>
<td>98 (56%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>31</td>
<td>(18%)</td>
<td>37 (21%)</td>
<td>44 (25%)</td>
</tr>
<tr>
<td>Severe</td>
<td>0</td>
<td>(0%)</td>
<td>4 (2%)</td>
<td>2 (1%)</td>
</tr>
</tbody>
</table>

AS indicates aortic stenosis; Vmax, maximal velocity; ∆P, pressure gradient; and AVA, aortic valve area.

*P<.0001 compared with baseline and 6-month follow-up.

tP=.009 compared with baseline.

Otto, Circulation. 1994;89:642-650.)
Percutaneous Balloon Aortic Valvuloplasty

Otto, Circulation. 1994;89:642-650.)
Percutaneous Balloon Aortic Valvuloplasty: Bridge to SAVR

- Methods:
  - 90 consecutive patients with severe AS undergoing BAV from 1990 to 2005
  - Patients with no immediate surgical option, BAV was attempted to temporarily improve hemodynamics, with a goal to improve general health of the patient, and ultimately AVR
  - 30% (27) of patients ultimately bridged to SAVR

Kapadia SR, J Interven Cardiol 2010;23:499–508)
Percutaneous Balloon Aortic Valvuloplasty: Bridge to SAVR

- **Methods:**
  - 33 patients (33%) with severe LV dysfunction, Cardiogenic Shock, Severe MR or Severe PHTN
    - 23 had no SAVR
    - 10 had SAVR

Kapadia SR, J Interven Cardiol 2010;23:499–508)
Percutaneous Balloon Aortic Valvuloplasty: Bridge to SAVR

Kapadia SR, J Interven Cardiol 2010;23:499–508)
The Role of Percutaneous Aortic Balloon Valvuloplasty in Patients with Cardiogenic Shock and Critical Aortic Stenosis*

310 BAV → 21 Shock → 9 death in hosp (42%) → 12 Survived to DC (58%)

<table>
<thead>
<tr>
<th>n = 19</th>
<th>Pre BAV</th>
<th>Post BAV</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP (mm Hg)</td>
<td>77 +/- 3</td>
<td>116 +/- 8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mn Grd (mm Hg)</td>
<td>49.4 +/- 4</td>
<td>21 +/- 3</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>AVA (cm2)</td>
<td>0.48 +/- 0.04</td>
<td>0.84 +/- 0.06</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>CI (L/min/m2)</td>
<td>1.84 +/- 0.13</td>
<td>2.24 +/- 0.15</td>
<td>= 0.06</td>
</tr>
</tbody>
</table>

*Moreno PR, et al. JACC Vol 23, No 5, April 1994:1071-5*
Efficacy Balloon Aortic Valvuloplasty for Critical AS in Patients with Shock*

Prospective analysis, 10-yr, 33 patients

14 Shock patients

10/14 In Hosp Mort (71%)

AVR within 16d 2/2 survive 1-yr

Refused AVR 2/2 survive 1-yr

19 Crit AS for Non-Cardiac Surgery

BAV

95% survival at one year

* Buchwald, AB, et al; Clin Cardiol 2001 Marc;24(3):214-8

Mechanical Therapy
In-hospital and long-term outcome of BAV in TAVR era*

<table>
<thead>
<tr>
<th>Mortality</th>
<th>Shock (23)</th>
<th>No Shock (392)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Hospital</td>
<td>56.5%</td>
<td>2%</td>
</tr>
<tr>
<td>1-Year</td>
<td>70%</td>
<td>21.7% (B-AVR)</td>
</tr>
<tr>
<td>2-Year</td>
<td>80.4%</td>
<td>38.4% (B-AVR)</td>
</tr>
</tbody>
</table>

*Saia F, et al; EuroIntervention 2013 Apr 22:8(12):1388-97*
Ventricular Assist Devices or Cardiopulmonary Bypass?

- **Tandem Heart**
  - Left Atrium – Centrifugal Pump – Femoral Artery

- **Impella**
  - Left Ventricle – micro-axial pump - Ascending Aorta

- **ECMO/Cardiopulmonary Bypass**
  - Fem Vein – Centrifugal Pump – O2 – Femoral Artery


TandemHeart as a Rescue Therapy for Patients With Critical Aortic Valve Stenosis

Restrospective review, 10 patients, Cardiac Arrest or Severe Refractory Cardiogenic Shock (SRCS)

<table>
<thead>
<tr>
<th></th>
<th>Before THP</th>
<th>After THP</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCWP, mm Hg</td>
<td>30.8 +/- 11.8</td>
<td>10.3 +/- 3.7</td>
<td>0.018</td>
</tr>
<tr>
<td>SBP, mm Hg</td>
<td>68 +/- 17</td>
<td>106 +/- 33</td>
<td>0.034</td>
</tr>
<tr>
<td>MAP, mm Hg</td>
<td>50 +/- 12</td>
<td>88 +/- 13</td>
<td>0.006</td>
</tr>
<tr>
<td>Vasopressors</td>
<td>2.1 +/- 0.7</td>
<td>0.7 +/- 0.9</td>
<td>0.002</td>
</tr>
<tr>
<td>Creat, mg/dL</td>
<td>2.0 +/- 0.9</td>
<td>1.1 +/- 0.3</td>
<td>0.002</td>
</tr>
</tbody>
</table>

8/8 to SAVR
7/8 survival at 2-43 mos
Impella 2.5 Support for Interventions in Patients with Aortic Stenosis* and LV dysfunction (NO shock patients)

- PCI = 3
- 21 pts (Retrospective)
- BAV + PCI = 8
- BAV + Arrest = 3
- BAV = 7

<table>
<thead>
<tr>
<th></th>
<th>Elective (n=17)</th>
<th>Emergent (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-Day Mortality</td>
<td>2 (12%)</td>
<td>1 (25%)</td>
</tr>
<tr>
<td>Complications</td>
<td>3 (17%)</td>
<td>1 (25%)</td>
</tr>
</tbody>
</table>

* n=5 moderate AS, n=15 severe AS
Martinez, CA et al; Catheterization & Cardiovascular Interventions; Volume 8, Issue 7, April 2012
**Transapical TAVR in patients with cardiogenic shock**

358 Consecutive Transapical Edwards

<table>
<thead>
<tr>
<th></th>
<th>Shock</th>
<th>No Shock</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euro Score</td>
<td>73.1 +/- 18.9%</td>
<td>36.0 +/- 18.7%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>STS</td>
<td>50.8 +/- 28.1%</td>
<td>16.7 +/- 12.2%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>CPB</td>
<td>10/21 (47.6%)</td>
<td>17/337 (5%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>30-d Mortality</td>
<td>19%</td>
<td>5%</td>
<td>0.02</td>
</tr>
<tr>
<td>1-y Survival</td>
<td>46%</td>
<td>83%</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Consecutive Transapical Edwards

Shock 21 (5.9%)

Case Study

- 97yo female transfer
- Intubated in Cardiogenic Shock
- OSU Echo
  - EF 26%
  - Mild RV dysfunction
  - Moderate-severe MR
  - Severe Aortic Valve Calcification
    - Mean gradient 67 mmHg, peak 108 mmHg
    - AVA 0.33 cm²
What Next?

Palliative Care

Mechanical Therapy

Severe AS+ Cardiogenic Shock

Medical Therapy
Emergently to Cath......

- No significant Coronary Disease
- Mean Gradient 69.85 mmHg
- Deteriorating with Dual lumen pigtail across ventricle
- Amplatz exchange wire placed in ventricle
- 6Fr sheath removed, Preclose placed, 12 Fr sheath placed
- Temporary wire placed RFV
BAV Results

- Mean gradient 48.5 (69.85)
- SBP increased from 80 to 135
- Weaned off Dopamine (20mcg) prior to transfer to the floor
- Extubated several days later and discharged to Skilled Nursing Facility on Hospital Day #10 with plans to follow-up in 1 week in TAVR Clinic
Readmission....

- Admitted 4 days later with Massive Saddle Embolus; Thrombolytics, EKOS in cath lab
- ARF, BiPap, but slowly recover over four days
- Patient and family request further discussion regarding goals of care
- Code status changed from DNR CCA to DNR CC
- Patient died comfortably on hospital day #10
Summary

- Critical AS and Cardiogenic shock is a bad combination
- Three is a paucity of data to support ideal management of these patients
- Aggressive Mechanical Therapy may be of benefit in some patients
- Goals of care should be established with all patients and families
  - Palliative Consultation should be utilized in all patients