My Patient has Aortic Stenosis: What We Need to Know About TAVR in 2017

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- Disclosure Statement of Financial Interest

**Grant Research Support**
- Abbott Vascular
- Medtronic
- CardioKinetix
- Boston Scientific
- Keystone
- SentraHeart

**Stock**
- CardioSolutions

*Off label use of products and investigational devices will be discussed in this presentation*
• Perspective
• Presentation
  • Natural History
• Diagnosis
  • Echocardiogram
  • Stress Testing
  • Left Heart Catheterization
  • CT Scan
  • MRI
• Treatment Options
  • AVR
  • TAVR
    • Valve options
    • Trials
  • New Complications
  • Cost
Pathophysiology and Prevalence

• Pathophysiology:
  • Progressive, degenerative disease of the native leaflets
  • Mechanism of stenosis is similar to atherosclerosis¹

Aortic Sclerosis

• Mild calcification
• No obstruction of blood flow

Aortic Stenosis

• Severe calcification
• Obstruction of blood flow

• Prevalence:
  • 2% of people over 65
  • 3% of people over 75
  • 4% of people over 85

Incidence and Prevalence

• Aortic stenosis is the most common acquired valvular disorder found in developed countries
  • Affects approximately 5 out of every 10,000 people in the United States
• Mild to severe AS present in up to 9% of adults over age 65 years
• The prevalence of calcific aortic stenosis increases with age and is expected to double in the next 20 years*

Aortic Stenosis: Symptoms
Triad of AS

• Cardinal Symptoms
  - Chest pain (angina)
  - Reduced coronary flow reserve
  - Increased demand - high afterload
  - Syncope/Dizziness (exertional pre-syncpe)
  - Fixed cardiac output
  - Vasodepressor response

• Congestive Heart Failure
  - Dyspnea on exertion & rest
  - Impaired exercise tolerance
  - Other signs of LV failure
  - Diastolic & systolic dysfunction
  - Sudden Cardiac Death

[Graph showing survival rate, onset of severe symptoms, and average survival with conditions related to aortic stenosis.]
• In the absence of serious comorbid conditions, aortic valve replacement (AVR) is indicated in the majority of symptomatic patients with severe aortic stenosis.

• Because of the risk of sudden death, AVR should be performed promptly after the onset of symptoms.

• Consultation with or referral to a Heart Valve Center of Excellence is reasonable when discussing treatment options for:
  • Asymptomatic patients with severe valvular heart disease
  • Patients with multiple comorbidities for whom valve intervention is considered

• Age is not a contraindication to Surgery

Nishimura, RA et al. 2014 AHA/ACC Valvular Heart Disease Guideline
Survival of Patients With Severe AS With and Without AVR

AS=aortic stenosis; AVR=aortic valve replacement.

5 year survival of breast cancer, lung cancer, prostate cancer, ovarian cancer and severe inoperable aortic stenosis
Diagnosis of Aortic Stenosis

- Echocardiography is the mainstay for the Diagnosis of Aortic Stenosis
  - Non invasive
  - Readily available
  - Able to Identify etiology
  - Can discover other valvular abnormalities

**CON:**
- operator dependent
- Can be misleading in complex anatomy
Survival in asymptomatic AS based on Vmax

Diagnosis of Aortic Stenosis

**Figure 1:** Principles of the Use of Doppler Ultrasonography and the Continuity Equation in Estimating Aortic-Valve Area. For blood flow \((A_1 \times V_1)\) to remain constant when it reaches a stenosis \((A_2)\), velocity must increase to \(V_2\). Doppler examination of the stenosis detects the increase in velocity, which can be used to calculate the aortic-valve gradient or to solve the continuity equation for \(A_2\). \(A\) denotes area, and \(V\) velocity.

**Dimensionless index (DI).**

\[
\text{DI} = \frac{V_{LVOT}}{V_{aorta}}
\]

In a DI \(\leq 25\), there is almost always a severe aortic valve stenosis.
Invasive Catheterization

- Usually performed to assess for CAD
- Can be performed when diagnosis by echocardiogram is inconclusive
- Simultaneous pressure measurements
- Also able to stimulate with dobutrex in EF less than 40%
Outcome of asymptomatic severe aortic stenosis and degree of valve calcification

Rosenhek et al NEJM 2000;343:611
Not so classic aortic stenosis
Low Flow, Low Gradient AS

• Low gradient with a small calculated valve area in the setting of poor systolic function. This may result in lack of referral for AVR because of the low gradient.

• Dobutamine Stress Echo:
  • By increasing cardiac output, we can determine if the AS is severe by reassessing the gradient across the aortic valve (increases) AND the aortic valve area (decreases).
  • Assess myocardial contractile reserve
    • Does the cardiac output improve by 20% or more.
  • Critical for decision making regarding aortic valve replacement.
Paradoxical Low Flow and/or Low Gradient Severe Aortic Stenosis

- Some patients with severe aortic stenosis based on valve area have a lower than expected gradient (e.g. mean gradient < 30 mmHg) despite preserved LV ejection fraction (e.g. EF > 50%)

- **Reduced LVSI <35ml/m2**

- **Up to 35% of patients** with severe aortic stenosis present with low flow, low gradient

- These low gradients often lead to an underestimation of the severity of the disease, so many of these patients do not undergo surgical aortic valve replacement
### Integration of Flow-Gradient Patterns Into Clinical Decision Making for Patients With Suspected Severe Aortic Stenosis and Preserved LVEF: A Systematic Review of Evidence and Meta-Analysis

<table>
<thead>
<tr>
<th>Suspected Severe Aortic Stenosis with Preserved LVEF</th>
<th>Reduced LVEF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HG</strong></td>
<td><strong>NFLG</strong></td>
</tr>
<tr>
<td>Vel ≥ 4 m/sec or MG ≥ 40 mm Hg</td>
<td>SVI ≥ 35 ml/m²</td>
</tr>
<tr>
<td></td>
<td>Vel &lt; 4 m/sec and</td>
</tr>
<tr>
<td></td>
<td>MG &lt; 40 mm Hg</td>
</tr>
<tr>
<td></td>
<td>AVA ≤ 1 cm²</td>
</tr>
<tr>
<td></td>
<td>(indexed ≤ 0.6 cm²/m²)</td>
</tr>
<tr>
<td>Symptoms + AVR Class I</td>
<td>Measurement verification</td>
</tr>
<tr>
<td>Symptoms – ETT Class Ia</td>
<td>No specific recommendation</td>
</tr>
<tr>
<td></td>
<td>LVSI &lt; 35 ml/m²</td>
</tr>
<tr>
<td></td>
<td>DI ≤ 25,</td>
</tr>
<tr>
<td></td>
<td>Dobutrex Echocardiogram to assess change in Valve Area and 20% improvement in EF</td>
</tr>
</tbody>
</table>

**NFLG**:
- SVI ≥ 35 ml/m²
- Vel < 4 m/sec and
- MG < 40 mm Hg
- AVA ≤ 1 cm² (indexed ≤ 0.6 cm²/m²)

**LFLG**:
- SVI < 35 ml/m²
- Vel < 4 m/sec and
- MG < 40 mm Hg
- AVA ≤ 1 cm² (indexed ≤ 0.6 cm²/m²)
- LVSI <35ml/m2
- DI ≤ 25,

**AVR Class Ia**

**Symptomatic BP controlled**
Prevalence of Aortic Stenosis in Patients Age 65 and Over

- U.S. Population > 65: 40M (U.S. Census, 2010)
- Prevalence Rate: 4% (Cardiovascular Health Study)
- Prevalence: 1.6M (Calculation)
- Operable AS (%): 20% (L.E.K. Consulting Estimate)

Annual AVR Patients: 60K
Addressable Patients: 320K

19% of those who would benefit from AVR actually get it.
Operative mortality of AVR in the elderly
Risk factors for operative mortality

- Functional class
- Lack of sinus rhythm
- HTN
- Pre-existing LV dysfunction
- Pulmonary Hypertension
- Aortic regurgitation
- Concomitant surgical procedures:
  - CABG/MV surgery
- Emergency surgery
- CAD
- Female gender
- DM
- Atrial Fibrillation
- Renal Failure
- Previous bypass
How to predict Mortality and Morbidity

•The Society of Thoracic Surgeons’ risk model calculates the risk of operative mortality and morbidity of adult cardiac surgery on the basis of patient demographic and clinical variables.
STS calculator:

141,905 patients in the STS database who underwent isolated surgical aortic valve replacement (SAVR) during roughly the past 6 years, 6% were high risk as defined by an STS predicted risk of mortality score greater than 8%. Another 14% were intermediate risk, with an STS score of 4%-8%. The remaining 80% were low risk, with an STS score of less than 4%.
Things not in the STS

Porcelain aorta
Hostile chest due to prior radiation therapy
Severe lung disease (FEV1 500ml : 25% predicated)
Advanced liver disease
Internal mammary artery graft crossing the midline
Moderate dementia
Assisted Living
Frailty
80 year old “eye Ball” test
Assessment of Frailty

• Gait Speed
• Grip Strength
• Activities of Daily Living
• Nutrition
• Mini-Mental Status Exam

• If someone fails three of these five measures, this generally rules out the option of SAVR.
Operative Risk

- LOW: SAVR or Randomized Trial
- Intermediate: TAVI or SAVR if special circumstances exist
- HIGH: TAVI
- Extreme: TAVI
- Futile: ?%
Where it all Started
April 16, 2002
Rigorous Clinical Trials Matter

• The CoreValve US Pivotal Extreme Risk Study and PARTNER IIB are both rigorously executed, prospective, controlled, multi-center trials with independent adjudication.
• These trials represent the most rigorous evaluation of CoreValve and Sapien XT in extreme risk/inoperable patients.

CoreValve US Pivotal Trial
Extreme Risk Iliofemoral Study Results

Jeffrey J. Popma, MD
On Behalf of the CoreValve US Clinical Investigators

A Randomized Evaluation of the SAPIEN XT Transcatheter Valve System in Patients with Aortic Stenosis Who Are Not Candidates for Surgery: PARTNER II, Inoperable Cohort

Martin B. Leon, MD
on behalf of The PARTNER Trial Investigators

TCT 2013  ACC 2013
NOTE: The charts are not intended to be a comparison of the two devices as there is no head-to-head clinical study, but rather are intended to illustrate the clinical results of two similar trials. Multiple factors contribute to clinical study outcomes and need to be considered in making any assessments across different studies.
Major Stroke

NOTE: The charts are not intended to be a comparison of the two devices as there is no head-to-head clinical study, but rather are intended to illustrate the clinical results of two similar trials. Multiple factors contribute to clinical study outcomes and need to be considered in making any assessments across different studies.
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New Technology = New Problems

• Paravalvular leak
  • Change a pressure issue for Volume issue
• New Permanent Pacemaker
• Stroke
  • Clinical events vs silent one
• COST
Prosthetic Aortic Regurgitation

Mechanisms

Transvalvular
- Defective leaflet
- Underdeployed stent
- Overexpanded prosthesis

Periprosthetic
- Aortic valve calcifications
- Bicuspid aortic valve
- Prosthesis undersizing
- LVOT - Aorta angulation
- Prosthesis malposition

Supra-skirtal
- Low (apical) implant
- Prosthesis design
Prosthetic Aortic Valve Regurgitation

Evaluation: Hemodynamic Criteria

CAVEATS
- IV Fluids
- Inotropes
- Vasopressors
- Anesthetics
- Bleeding
- Pericardial effusion

↓ Ao dBP
↑ LVEDP
Prosthetic Aortic Valve Regurgitation

Evaluation: Hemodynamic Criteria

Aortic Regurgitant Index (ARI) = \( \frac{\text{dBP} - \text{LVEDP}}{\text{sBP}} \)

\[ \frac{50 - 10}{130} = 0.308 \]

\[ \text{ARI} = 30.8 \]
Prosthetic Aortic Valve Regurgitation

Evaluation: Hemodynamic Criteria

WHERE THE NUMBER MAY NOT TELL IT ALL.....

ARI = \frac{dBP - LVEDP}{sBP} = \frac{50 - 10}{130} = 30.8

ARI = \frac{dBP - LVEDP}{sBP} = \frac{40 - 20}{120} = 16.6
Paravalvular AR and Mortality
PARTNER Trial – Cohort A

<table>
<thead>
<tr>
<th>Paravalvular AR</th>
<th>Numbers at Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>None-Trace</td>
<td>None-Trace</td>
</tr>
<tr>
<td>Mild-Mod-Sev</td>
<td>Mild-Mod-Sev</td>
</tr>
<tr>
<td>167</td>
<td>160</td>
</tr>
<tr>
<td>149</td>
<td>143</td>
</tr>
<tr>
<td>140</td>
<td>134</td>
</tr>
<tr>
<td>126</td>
<td>112</td>
</tr>
<tr>
<td>87</td>
<td>101</td>
</tr>
<tr>
<td>41</td>
<td>64</td>
</tr>
<tr>
<td>16</td>
<td>26</td>
</tr>
</tbody>
</table>

Months Post Procedure

Mortality

HR [95% CI] = 2.01 [1.38, 2.92]
p (log rank) = 0.0002
Paravalvular AR and Mortality
PARTNER Trial – Cohort A

Even Mild PVL Matters

<table>
<thead>
<tr>
<th>Months Post Procedure</th>
<th>None-Tr</th>
<th>Mild</th>
<th>Mod-Sev</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>167</td>
<td>136</td>
<td>24</td>
</tr>
<tr>
<td>6</td>
<td>149</td>
<td>115</td>
<td>19</td>
</tr>
<tr>
<td>12</td>
<td>140</td>
<td>95</td>
<td>17</td>
</tr>
<tr>
<td>18</td>
<td>126</td>
<td>86</td>
<td>15</td>
</tr>
<tr>
<td>24</td>
<td>87</td>
<td>51</td>
<td>13</td>
</tr>
<tr>
<td>30</td>
<td>41</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>36</td>
<td>16</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

Numbers at Risk

Mortality

- None - Trace
- Mild
- Moderate - Severe

p (log rank) < 0.001

Paravalvular AR and Mortality
Even Mild PVL Matters
Impact of PVL on Late Mortality
Self Expanding Valve (Medtronic CoreValve)

Log rank P Value <0.0001

None/Trivial N=208
Mild N=180
Moderate N=54
Severe N=8

TCT 2013 LBCT (JACC 2014)
Paravalvular Regurgitation

83% of patients with moderate PVL at discharge who survived to one year experienced a reduction in PVL over time.
Direct Flow TAVR (DISCOVERY)
PVL - 1 year (n=100)
Conduction Disturbances after TAVR

LBBB and PPM are Frequent Complications due to:

• High Frequency of Comorbid Conduction Disease
• Close Anatomic Proximity of Aortic Valve and Conduction System
Incidence of PPM post TAVR

- Recent large meta-analyses

- Khatri: 44 studies with 12,116 patients
  - 4602 MCV, 6074 ESV
  - Overall PPM 13%
  - MCV 25% vs ESV 6%

- Siontis: 41 studies with 11,210 patients
  - 5398 MCV, 5812 ESV
  - Overall PPM 17%
  - Median MCV 28% vs ESV 6%

Siontis et al. JACC 2014
No association of PPM with 1-year Mortality

ADVANCE: 996 MCV

PARTNER: 1973 ESV

1556 TAVR: 698 MCV, 858 ESV

Wenaweser et al. PCR 2013
Urena et al. Circulation 2014
Clinical Impact of PPM after TAVR

PARTNER  N = 1973

Nazif et al. JACC Interv 2015
Impact of PPM after TAVR on LVEF

N=1556: MCV 698, ESV 858

Pacing at 6-12 mo. in 67% (MCV 73, ESV 47)

Urena et al. Circulation 2014;129:1233-43
## Meta-analysis: Predictors of PPM

### Any valve

<table>
<thead>
<tr>
<th>Predictor</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>RR (95% CI)</th>
<th>p-value</th>
<th>I-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age&gt;80</td>
<td>1</td>
<td>1,147</td>
<td>1.17 (0.98-1.41)</td>
<td>0.09</td>
<td>-</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>17</td>
<td>3,621</td>
<td>1.23 (1.10-1.38)</td>
<td>&lt;0.01</td>
<td>0%</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>15</td>
<td>3,215</td>
<td>1.16 (0.96-1.41)</td>
<td>0.12</td>
<td>25%</td>
</tr>
<tr>
<td>First-degree AV block</td>
<td>6</td>
<td>1,381</td>
<td>1.62 (1.15-2.01)</td>
<td>&lt;0.01</td>
<td>4%</td>
</tr>
<tr>
<td>Left anterior hemiblock</td>
<td>5</td>
<td>1,065</td>
<td>1.62 (1.17-2.25)</td>
<td>&lt;0.01</td>
<td>0%</td>
</tr>
<tr>
<td>Left posterior hemiblock</td>
<td>1</td>
<td>167</td>
<td>1.14 (0.90-1.43)</td>
<td>0.91</td>
<td>-</td>
</tr>
<tr>
<td>Intraoperative AV block</td>
<td>2</td>
<td>333</td>
<td>3.49 (2.49-4.89)</td>
<td>&lt;0.01</td>
<td>-</td>
</tr>
<tr>
<td>LBBB</td>
<td>16</td>
<td>2,371</td>
<td>1.01 (0.80-1.27)</td>
<td>0.93</td>
<td>0%</td>
</tr>
<tr>
<td>RBBB</td>
<td>17</td>
<td>2,158</td>
<td>2.89 (2.36-3.54)</td>
<td>&lt;0.01</td>
<td>44%</td>
</tr>
<tr>
<td>PR&gt;200 msec</td>
<td>1</td>
<td>50</td>
<td>1.45 (0.59-3.62)</td>
<td>0.42</td>
<td>-</td>
</tr>
<tr>
<td>MCRS (versus ESV)</td>
<td>9</td>
<td>5,131</td>
<td>2.54 (2.08-3.12)</td>
<td>&lt;0.01</td>
<td>14%</td>
</tr>
<tr>
<td>Preserved LVEF</td>
<td>4</td>
<td>805</td>
<td>1.26 (0.78-2.02)</td>
<td>0.35</td>
<td>12%</td>
</tr>
</tbody>
</table>

Siontis et al. JACC 2014
### Predictors of PPM after TAVR

<table>
<thead>
<tr>
<th>Study</th>
<th>MCV</th>
<th>ESV</th>
<th>Predictors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nazif 2014</td>
<td></td>
<td>1973</td>
<td>RBBB (OR 7.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Prosthesis/LVOT (OR 1.3 per 0.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LVEDd (OR 0.68 per 1 cm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Registry vs RCT (OR 1.8)</td>
</tr>
<tr>
<td>Ledwoch 2013</td>
<td>912</td>
<td>232</td>
<td>MCV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Porcelain aorta</td>
</tr>
<tr>
<td>Munoz-Garcia 2012</td>
<td>195</td>
<td></td>
<td>RBBB (OR 3.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Depth implantation (OR 1.2)</td>
</tr>
<tr>
<td>Khawaja 2011</td>
<td>243</td>
<td></td>
<td>Periprocedure AVB (OR 6.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>QRS duration (OR 3.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BAV (OR 2.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Prosthesis &gt; 26mm (OR 2.5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IVSD (OR 1.2)</td>
</tr>
</tbody>
</table>

**EKG Features:** RBBB, LAFB, QRS duration

**Anatomic:** Calcification, IVSD

**Procedural:** MCV, Depth, BAV, Over-sizing
Dyssynchrony and Ventricular Function

• LBBB results in LV dyssynchrony and adverse outcomes in diverse patient populations with heart disease

• RV apical pacing mimics LBBB
  • In patients with LV systolic dysfunction, RV pacing associated with heart failure and mortality (DAVID, BLOCK HF)
  • Even in setting of normal EF, RV pacing associated with increased heart failure (MOST)
  • RV pacing burden > 40-50% associated with decrease in EF and adverse outcomes (MOST, MADIT-II)

Conduction Disturbances after TAVR and LV Function

90 TAVR Recipients: 39 persistent, new conduction defects

**Table 3. Analysis of LV Contraction Synchrony Using Echocardiographic Deformation Imaging**

<table>
<thead>
<tr>
<th></th>
<th>New Conduction Disturbance (n = 39)</th>
<th>No New Conduction Disturbance (n = 51)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-TAVI Δ time-to-peak systolic radial strain, ms</td>
<td>36 ± 24</td>
<td>29 ± 22</td>
<td>0.101</td>
</tr>
<tr>
<td>1-month post-TAVI Δ time-to-peak systolic radial strain, ms</td>
<td>139 ± 35</td>
<td>38 ± 34</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Values are mean ± SD. Δ Time-to-peak systolic radial strain relates to the time difference to peak systolic strain between the 6 analyzed segments of the short axis image. Abbreviations as in Table 2.
Impact of New LBBB Stratified by Baseline LVEF

Detrimental effect of LBBB on subsequent improvement of LVEF
Most pronounced among those with baseline LV dysfunction

Strategies to Minimize Conduction Disturbances: Requirement for BAV

• Continuous monitoring shows up to 50% of conduction disturbances occur during wire manipulation and BAV

• Lange et al: 237 MCV
  • PPM 27.1% if 25mm BAV, 15.4% if <= 23mm BAV

• Grube et al: 60 MCV without preceding BAV
  • PPM 11.7% (historical control 27.8%)

The Advance II Study

- Prospective study of PPM rate after CoreValve with target implantation depth < 6mm and Class I/II Guideline indications for PPM
  - 194 MCV: overall PPM 24.4%
  - PPM 13.3% if < 6mm and Class I/II Indication
  - However, despite high-volume, expert sites, depth < 6mm was only achieved in 43%

Petronio et al. JACC Cardiovasc Interv 2015
Depth of Implantation: MCV

70 Patients s/p MCV

Gueta et al. AJC 2011
Balance of the Evidence

Houthuizen (N=697)
Pereira (N=58)

TOTAL N= 755

Testa (N=879)
DeCarlo (N=275)
Wenaweser (N=508)
Franzoni (N=238)
Urena (N=668)
Nazif (N=1151)

TOTAL N=3719
Mitigating Stroke Risk in TAVR: Important Considerations as TAVR Moves to Lower-Risk Patients
Consequences of Stroke

❖ Mortality – TAVR patients suffering a VARC-2 disabling stroke have significantly higher mortality rates compared to patients without stroke. 1-year mortality of 67% vs. 12% and 2-year mortality of 83% vs. 20%.1

❖ Physical Functioning – 40% of overt ischemic strokes lead to moderate to severe permanent disability and even 55%-75% of “fully recovered” patients will have residual dysfunction in at least one limb.2-3

❖ Effect of Stroke in Working Population – Only 44% of overt stroke patients are able to return to work, 33% reported significant financial strains, and 79% reported a decrease in social activities.4

Stroke Underreported in TAVR Studies

In reported clinical trials stroke rates with TAVR range from 1.6%-5.9%

1) Van Mieghem (MISTRAL)
2) Messé (SAVR)
3) Lansky (DIII)
4) Lansky (NeuroTAVR)
5) Haussig (CLEAN TAVI)

Embolic Protection with TAVR

DW-MRI in patients who underwent TAVR without embolic protection - multiple cerebral emboli.
Current Cerebral Protection Devices

**TriGuard Embolic Deflection Device (Keystone Heart)**
- **Pore Size**: 130 µm
- **Delivery Sheath**: 9F
- **Access**: Transfemoral
- **Mechanism**: Debris deflection

**Sentinel Cerebral Protection System (Claret Medical)**
- **Pore Size**: 140 µm
- **Delivery Sheath**: 6F
- **Access**: Brachial or radial
- **Mechanism**: Debris capture and retrieval

**Embrella Embolic Deflector System (Edwards Lifesciences)**
- **Pore Size**: 100 µm
- **Delivery Sheath**: 6F
- **Access**: Brachial
- **Mechanism**: Debris deflection

---

“Silent” Cerebral Emboli & TAVR

- Every step of TAVR puts a patient at risk of stroke (crossing the aortic valve, valvuloplasty, valve placement, etc.). \(^1\)

- Cerebral embolization demonstrated by DWI MRI is common with TAVR occurring in 68-98% of cases. \(^2\)-\(^4\)

- Cerebral emboli detected on DWI MRI increase the risk of clinically overt stroke by 2-4 times and lead to cognitive dysfunction, depression, impaired mobility, dementia, and increased mortality. \(^5\)-\(^6\)

- The greater the volume of DWI lesions seen on MRI the greater the long-term risk of cognitive dysfunction and long-term dementia. \(^5\)-\(^6\)
The Case *against* Embolic Protection

- Stroke rates are decreasing
- Current devices don’t reliably protect all cerebral vessels
- Increases complexity and risk of procedure
- Manipulation of cerebral vessels
- Additional vascular access
- No study has proven any clinical benefit and MRI changes are not an adequate surrogate endpoint

- Emboli distribution to cerebral circulation is not in concordance with volumetric flow assumptions
- Cardiogenic emboli moves preferentially to right hemisphere

Patient Level - Consequences of Cerebral Emboli in Lower Risk Patients

High-Risk Patients
- Elderly
- Many co-morbidities
- Frail
- Retired
- Limited Activity
- Likely to be dependent on others
- Likely to be living in a supported environment

Lower-Risk Patients
- Younger
- Other than AS may be relatively healthy
- More robust
- Possibly still working
- High functional capacity
- Others in family may depend on them financially
- Likely to be independent

A disabling stroke or even mild cognitive impairment in a younger, fully functional, employed patient would be devastating for a patient and for their loved ones.
A “silent” infarct is still an infarct whether random or iatrogenic

Until someone proves these DWI lesions are somehow beneficial to the patient, we need to take steps to prevent them from occurring
Hospital Administrator After looking at the books of the TAVR Program
TAVR Economics: Why do we care?

- TAVR is expensive
  - Valve currently costs ~6x more than comparable surgical valve
  - Less expensive alternatives exist for many patients who are now being considered for TAVR (e.g., intermediate risk)

- Concerns about whether it’s appropriate to prolong life for some extreme risk patients
  - Are we doing the right thing?
  - Are there better uses for these resources?

- Population of eligible patients is large and growing ➔ even if TAVR is cost-effective, we may not be able to afford it for all patients
What drives costs of TAVR?

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve</td>
<td>$30,960</td>
</tr>
<tr>
<td>Complications</td>
<td>$11,324</td>
</tr>
<tr>
<td>Everything Else</td>
<td>$35,998</td>
</tr>
</tbody>
</table>

**Implications**

- Complications account for 24% of non-implant related costs → substantial opportunity for savings
- Even greater opportunity for savings from maximizing efficiency of care for uncomplicated admissions (8 day LOS in PARTNER)

<table>
<thead>
<tr>
<th></th>
<th>Minimalist</th>
<th>Standard</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure time</td>
<td>93 min</td>
<td>125 min</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Room time</td>
<td>150 min</td>
<td>218 min</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LOS (post-procedure)</td>
<td>3 days</td>
<td>5 days</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LOS (ICU)</td>
<td>22 hrs</td>
<td>28 hrs</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hospital cost</td>
<td>$45,485</td>
<td>$55,377</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cost (excl. valve)</td>
<td>$12,985</td>
<td>$22,877</td>
<td>N/A</td>
</tr>
<tr>
<td>Valve</td>
<td>$32,500</td>
<td>$32,500</td>
<td>NA</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$90,970</strong></td>
<td><strong>$110,754</strong></td>
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</tr>
</tbody>
</table>
# Expected TAVR Reimbursement for Louisiana Hospitals

<table>
<thead>
<tr>
<th>Hospital</th>
<th>DRG 267 (No MCC)</th>
<th>DRG 266 (with MCC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our Lady of the Lake</td>
<td>$38,071</td>
<td>$50,401</td>
</tr>
<tr>
<td>Baton Rouge General</td>
<td>$39,842</td>
<td>$52,748</td>
</tr>
<tr>
<td>Lafayette General</td>
<td>$36,322</td>
<td>$48,149</td>
</tr>
<tr>
<td>Regional West Medical Center</td>
<td>$37,481</td>
<td>$49,799</td>
</tr>
<tr>
<td>Lane Regional Medical Center</td>
<td>$36,263</td>
<td>$48,044</td>
</tr>
<tr>
<td>Ochsner Medical Center BR</td>
<td>$37,831</td>
<td>$49,900</td>
</tr>
<tr>
<td>Terrebonne General Medical Center</td>
<td>$39,089</td>
<td>$51,722</td>
</tr>
<tr>
<td>Ochsner Medical Center</td>
<td>$45,013</td>
<td>$59,359</td>
</tr>
</tbody>
</table>
Conclusion

• Trans-catheter Aortic Valve Replacement (Implantation)
  • Offering Extreme, High risk and Intermediate risk Patients with Aortic Stenosis a treatment option versus Open surgical Replacement
  • New Different Complications
    • Paravalvular Leak
    • Pacemaker/LBBB
    • Silent Ischemic event
    • Increased Vascular Complications
    • Ventricular Pseudoaneurysm (Apical Access)
    • Annular Rupture

• Disruptive /Transformative/Very Expensive Technology
• As we continue to explore lower and lower risk patients major question needs to be answered ... Valve longevity, longterm neuro effect, new pacer, LBBB effect
• Can we afford this technolgy?
My Patient has Aortic Stenosis:
What We Need to Know About TAVR in 2017

Peter S. Fail, MD FACC, FACP, FSCAI
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And Interventional Research
Director of the Structural Heart Program
Cardiovascular Institute of the South