Transcatheter Aortic Valve Replacement: Emerging Devices, Indications, and Techniques

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Perelman School of Medicine
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Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

- **Grant/Research Support**
  - Abbott Vascular
  - Edwards Lifesciences
  - St. Jude Medical
  - Medtronic
  - Gore
  - Siemens

- **Consulting Fees/Honoraria**
  - Bayer
  - Boston Sci
  - Corvia
  - Cardiokinex
  - Univ Laval
  - Edwards Lifesciences
  - Bayer
  - Wells Fargo
  - Leerink

- **Equity**
  - Microinterventional Devices

- **Discussion may include unapproved and off-label devices, procedures, and indications**
Penn TAVR Program Has High Visibility and Prestige

More than 50 publications in major journals, including NEJM, Circulation, Lancet, JACC

One of the 5 largest programs in the US

Sought after participant in national trials of new devices, adjunctive therapies

- 4 major devices
- Embolic protection trial
- Anticoagulation post TAVR trial
- Membership on steering committees
- Presentations at multiple national meetings
Future of Transcatheter Aortic Therapies

- New Devices
  - Portico
  - Lotus
  - Jenavalve
- New Indications
  - Low Risk
  - Aortic Regurgitation
  - Bicuspid aortic valves
  - Asymptomatic AS
  - Low Flow vs Pseudo AS
  - Moderate AS / LV dysfunction
- New Techniques
  - Conscious Sedation / MAC / Fast Track
  - Post TAVR anticoagulation
  - Cerebral Embolic Protection

New Devices: Lotus

- Valve deployed via controlled mechanical expansion.
  - It is neither balloon expandable nor self expanding.
- No rapid pacing during deployment
- Valve functions early enabling controlled deployment
- No valve movement on release
Lotus Deployment

Lotus Results: Respond Extension Study

Core Lab-Adjudicated Data

Aortic Regurgitation

<table>
<thead>
<tr>
<th>Percentage of Evaluable Echocardiograms</th>
<th>Baseline (n=44)</th>
<th>Discharge (n=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe</td>
<td>13.6% (2.3)</td>
<td>14.7% (67.6)</td>
</tr>
<tr>
<td>Moderate</td>
<td>31.8% (31.8)</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>31.8% (20.5)</td>
<td></td>
</tr>
<tr>
<td>Trace</td>
<td></td>
<td>8.8% (2.3)</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td>11.8% (17.6)</td>
</tr>
</tbody>
</table>

Paravalvular Leak (PVL)

- Permanent pacemaker implantation
  - All patients (n=50) 16% (8)
  - Pacemaker-naive patients (n=45) 17.8% (8)
Future of Transcatheter Aortic Therapies

- New Devices
  - Portico
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  - Jenavalve

- New Indications
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  - Conscious Sedation / MAC / Fast Track
  - Post TAVR anticoagulation
  - Cerebral Embolic Protection

Low Risk TAVR Trials

<table>
<thead>
<tr>
<th>Sponsor</th>
<th>Edwards (NCT02675114)*</th>
<th>Medtronic (NCT02701283)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
<td>Sapien 3</td>
<td>Evolut R / EnVeo R</td>
</tr>
<tr>
<td>Design</td>
<td>Prospective, randomized</td>
<td>Prospective, randomized</td>
</tr>
<tr>
<td>Comparator</td>
<td>1:1 to SAVR</td>
<td>1:1 to SAVR</td>
</tr>
<tr>
<td>Analysis</td>
<td>Non-inferiority</td>
<td>Non-inferiority</td>
</tr>
<tr>
<td>N</td>
<td>1228</td>
<td>1250</td>
</tr>
<tr>
<td>Inclusion</td>
<td>Heart team risk &lt;4%</td>
<td>Heart team risk &lt;3%</td>
</tr>
<tr>
<td>Substudy</td>
<td>Leaflet mobility (n=400)</td>
<td>Leaflet mobility (n=400)</td>
</tr>
<tr>
<td>PI</td>
<td>Leon / Mack</td>
<td>Popma / Reardon</td>
</tr>
<tr>
<td>1st endpoint</td>
<td>All-cause mort / all stroke / rehosp. (1 year)</td>
<td>All-cause mort / disabling stroke (2 year adaptive)</td>
</tr>
<tr>
<td>Key differences</td>
<td>Excludes EF &lt;45%, age&lt;65 Includes Asx with +ETT</td>
<td>Can include Asx AS with &gt;5.0 m/s, +ETT</td>
</tr>
</tbody>
</table>

* Source: Clinicaltrials.gov
The data already support TAVR in extreme and high risk patients, but the main reason that TAVR will eventually replace open surgery in intermediate and low risk patients is:

<table>
<thead>
<tr>
<th>TAVR for Pure Native Aortic Regurgitation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image 1" />  <img src="image2.png" alt="Image 2" /></td>
</tr>
</tbody>
</table>

Penn Medicine
• 237 Patients
  • 79% SE and 21% BE
• Device success lower
  • Second valve implanted in 7%
  • Moderate or severe AR persisted at 30d in 9%
• Conclusion: Feasible

JenaValve Pericardial THV

Available From:
Penn Medicine

THV PORCINE PERICARDIAL
TISSUE CUSPS
TA AND TF DELIVERY

Courtesy of U. Schaefer, MD, Hamburg UKE
• Higher rates of:
  • PVL
  • PPM
  • Early mortality

• Issues include:
  • Incomplete prosthesis expansion
  • Leaflet asymmetry
  • Annular disruption

• Future measurements:
  • Intercommissural distance
  • Raphe length, width, Ca++
  • Sinus asymmetry
  • Leaflet asymmetry

Sievers JTCVS 2007;133:1226
Jilaihawi JACC Imag 2016;9:1145
Popma JACC Imag 2016;9:1159

Balloon sizing with BAV

Annulus measured 620 mm2  (#29 Sapien 3)
Balloon valvuloplasty with 20 mm (6 cm) Tyshak-X
Downsized to #26 Sapien 3
Transcatheter Aortic Valve Replacement With Early- and New-Generation Devices in Bicuspid Aortic Valve Stenosis

• 301 patient registry: Results are improving with later generation devices

Recommendations and Levels of Evidence for Diagnosis, Follow-up, and Timing of Aortic Valve Replacement in Patients With Asymptomatic Severe Aortic Stenosis

**Indications for aortic valve replacement**

<table>
<thead>
<tr>
<th></th>
<th>ACC/AHA</th>
<th>ESC/EACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left ventricular ejection fraction (&lt;50%)</td>
<td>I, B</td>
<td>I, C</td>
</tr>
<tr>
<td>Undergoing other cardiac surgery</td>
<td>I, B</td>
<td>I, C</td>
</tr>
<tr>
<td>Symptoms on exercise test clearly related to aortic stenosis</td>
<td>I, B</td>
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<tr>
<td>Decreased exercise tolerance</td>
<td>IIa, B</td>
<td>IIa, C</td>
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<td>Exercise fall in systolic blood pressure</td>
<td>IIa, B</td>
<td>IIa, C</td>
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<tr>
<td>Very severe AS (PV (&gt;5.0\ m/s\ [ACC]; &gt;5.5\ m/s [ESC] and low surgical risk)</td>
<td>IIa, B</td>
<td>IIa, C</td>
</tr>
</tbody>
</table>

**3 Class I indications…3 Class IIa indications…**

**Level of evidence B or C**

**No Randomized trial**

**Follow-up**

<table>
<thead>
<tr>
<th></th>
<th>ACC/AHA</th>
<th>ESC/EACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echocardiography every 6-12 months</td>
<td>I, C</td>
<td></td>
</tr>
</tbody>
</table>

ACC = American College of Cardiology; AHA = American Heart Association; EACTS = European Association for Cardio-Thoracic Surgery; European ESC = European Society of Cardiology
Asymptomatic Severe Aortic Stenosis May Not Be as Benign as Previously Thought

- Japan multicenter registry
- 1,808 asymptomatic patients
- Two groups of initial AVR and conservative strategy

In the conservative group, AVR was performed in 41% of patients during follow-up

EARLY- TAVR Trial in planning stages


Recommendations and Levels of Evidence for Timing of Aortic Valve Replacement in Patients With Asymptomatic Severe AS

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<th>ACC/AHA</th>
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<tr>
<td>Exercise fall in systolic blood pressure</td>
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<td>Ila, C</td>
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<tr>
<td>Very severe AS (PV ≥5.0 m/s [ACC]; &gt;5.5m/s [ESC] and low surgical risk)</td>
<td>Ila, B</td>
<td>Ila, C</td>
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3 Class I Indications…3 Class Ila Indications…

Level of Evidence B or C

No Randomized Trial

Note: ACC, American College of Cardiology; AHA = American Heart Association; EACTS, European Association for Cardio-Thoracic Surgery; ESC, European Society of Cardiology; AS, Aortic stenosis; PV, Peak velocity

Nishimura et al. J Am Coll Cardiol. 2014; 63(22):e57-185
Why Early SAVR In Asymptomatic Severe AS is Rarely Performed?

<table>
<thead>
<tr>
<th>Sudden Death</th>
<th>Peri-operative Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe Asymptomatic AS</td>
<td>SAVR</td>
</tr>
<tr>
<td>~1-2%/year</td>
<td>~1-5%</td>
</tr>
</tbody>
</table>

*TAVR may be a better option for Asymptomatic patients*

<table>
<thead>
<tr>
<th>30-day Mortality</th>
<th>PARTNER Trial 2A Intermediate PM</th>
<th>Notion Trial all-comers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Valve TAVR</td>
<td>Sapien 3 TAVR</td>
<td>SAVR</td>
</tr>
<tr>
<td>2.1%</td>
<td>1.1%</td>
<td>3.7%</td>
</tr>
<tr>
<td>SAVR</td>
<td>SAVR</td>
<td></td>
</tr>
<tr>
<td>4.0%</td>
<td>4.0%</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

**Note:** AVR, aortic valve replacement; AS, Aortic stenosis
Prevalence of Asymptomatic Severe AS

- From Echocardiographic Databases / Laboratory:
  - Approx. 46-52% of all severe AS were asymptomatic
  - Approx. 22% of all severe AS were isolated asymptomatic severe AS
- Approx. 500,000 patients >65 years old in US

Study Objective and Design

Study Objective: To establish the safety and effectiveness of the Edwards SAPIEN 3 Transcatheter Heart Valve (THV) compared with clinical surveillance (CS) in asymptomatic patients with severe, calcific aortic stenosis.

Study design: Prospective, randomized, controlled, multi-center study

Sample size: 1109 patients

Study sites: Up to 65 US sites

Randomization: TAVR arm vs. Clinical Surveillance arm in 1:1 ratio

Registry: Patients meet all other criteria in study screening but with a positive result in the treadmill stress test
**Study Flowchart**

Asymptomatic, Severe Aortic Stenosis

**Screening**
Not eligible if <65, has Class I indication for AVR, bicuspid valve, not suitable for transfemoral access or STS >10

**Asymptomatic**
Negative treadmill stress test OR confirmation via medical history*

Randomization 1:1
Stratified by ability to perform treadmill stress test

- Transfemoral - TAVR
- Clinical and Echo Follow-up: 30 days (TAVR only), 1, 2, 3 and 5 years
- Primary Endpoint (superiority): 2-year composite of all-cause death, all stroke, and unplanned cardiovascular hospitalization

**Symptomatic**
Positive treadmill stress test

Registry
Commercial AVR (TAVR or SAVR), Clinical Trial (P3), etc.

Telephone Follow-up: 1, 2, 3 and 5 years

---

**THE EARLY TAVR TRIAL**

NCT03042104; 1st patient consented March 16th

Asymptomatic Severe, Calcific AS

**Screening**
Not eligible if <65, has Class 1 indication for AVR, bicuspid valve, not suitable for TF access or STS > 10

**Asymptomatic N=1,109 pts**
Negative stress test OR confirmation via medical history*

Randomization 1:1
Stratified by ability to perform stress test

- TF-TAVR
- Clinical and Echo Follow-up: 30 days (TAVR only), 1, 2, 3 and 5 years
- Primary Endpoint (superiority): 2-year composite of all-cause death, all stroke, and unplanned cardiovascular hospitalization

**Symptomatic N=1,000 pts**
Positive stress test

Registry
Commercial AVR (TAVR or SAVR), Clinical Trial (P3), etc.

Telephone Follow-up: 1, 2, 3 and 5 years

Principal Investigator:
Philippe Généreux, MD

Chair:
Martin B. Leon, MD
EARLY TAVR: Conclusion

- **EARLY TAVR trial** is a strategy trial aiming to establish the safety and effectiveness of early TAVR among patients with severe asymptomatic AS compared to clinical surveillance/delayed AVR
- **EARLY TAVR registry** is a prospective registry aiming to follow patients with severe AS initially deemed asymptomatic but with symptoms unmasked by stress testing

Practical Issues with “Watchful Waiting” Strategy

- Clinicians still have a fear of stress test with Severe AS patients; low penetration and underused; missing Class 1 indication for AVR
- Stress Imaging requires expertise and specific set-up that most community hospitals don’t have
- Sub-optimal follow-up and lost of follow-up are frequent
- Many sudden deaths occurred in Asx patients with no Class I indication of AVR and no preceding symptoms
- “Wishful Thinking” Strategy…
All Aortic Stenoses Are Not Created Equal

Anjan and Herrmann, JACC 2015;65:654-6

Pre-TAVR effect on outcome
KM mortality for LF vs NF

Anjan and Herrmann, JACC 2015;65:654-6
How to confirm severe AS when gradient, flow, or EF are reduced?

- Dobutamine stress echo to increase flow, observe an increase in gradient with minimal increase in AVA (classical LF LG AS)

- Dimensionless index <0.25 useful in paradoxical LF LG AS

- MDCT aortic valve calcification (total or density; gender specific)

When flow is normal (incorporates SVI and EF), AVA is true:

1 Rusinaru, JACC Cardiol Imag 2015;8:766-75
2 Cueff, Heart 2011;97:721-726
3 Chahal, JACC CV Imag 4.21.2015 online

Procedural Results
Outcomes in LF vs NF by Treatment Received (Cohort A)

Numbers at Risk

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>179</td>
<td>180</td>
<td>152</td>
<td>152</td>
</tr>
<tr>
<td>60</td>
<td>178</td>
<td>176</td>
<td>151</td>
<td>151</td>
</tr>
<tr>
<td>120</td>
<td>152</td>
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<tr>
<td>180</td>
<td>127</td>
<td>125</td>
<td>124</td>
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<td>240</td>
<td>123</td>
<td>122</td>
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<td>300</td>
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<td>360</td>
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<td>108</td>
<td>110</td>
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<tr>
<td>420</td>
<td>102</td>
<td>101</td>
<td>107</td>
<td>107</td>
</tr>
<tr>
<td>480</td>
<td>86</td>
<td>85</td>
<td>95</td>
<td>95</td>
</tr>
</tbody>
</table>

Herrmann et al, Circulation 2013;127:2316
Studies of Outcomes of Surgery in Classical LF LG severe AS

<table>
<thead>
<tr>
<th>Series</th>
<th>N</th>
<th>Peri-op or 30 day Mortality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF, LG, LEF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blitz, 1998</td>
<td>52</td>
<td>11%</td>
</tr>
<tr>
<td>Monin, 2003</td>
<td>95</td>
<td>14%</td>
</tr>
<tr>
<td>Kulik, 2006</td>
<td>70</td>
<td>8%</td>
</tr>
<tr>
<td>Clavel, 2008</td>
<td>44</td>
<td>18%</td>
</tr>
<tr>
<td>Levy, 2008</td>
<td>217</td>
<td>16%</td>
</tr>
</tbody>
</table>

1-year (Mortality) 5-year

<table>
<thead>
<tr>
<th>Series</th>
<th>N</th>
<th>1-year 5-year</th>
</tr>
</thead>
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<td>LF, LG, LEF</td>
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<td></td>
</tr>
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<td>Blitz, 1998</td>
<td>52</td>
<td>29% 34%</td>
</tr>
<tr>
<td>Monin, 2003</td>
<td>95</td>
<td>29% 34%</td>
</tr>
<tr>
<td>41 (no AVR)</td>
<td></td>
<td>60%</td>
</tr>
<tr>
<td>Kulik, 2006</td>
<td>79</td>
<td>11% 24%</td>
</tr>
<tr>
<td>Clavel, 2008</td>
<td>44</td>
<td>30%</td>
</tr>
<tr>
<td>57 (no AVR)</td>
<td></td>
<td>30%</td>
</tr>
<tr>
<td>Levy, 2008</td>
<td>217</td>
<td>25% 51%</td>
</tr>
</tbody>
</table>

*Percentages approximated by extrapolation from KM curves; #~50% AVR

How does TAVR differ from Surgery?

- TAVR is less invasive:
  - Faster recovery
  - Less pericardial irritation with potential for less AF
  - Less healing, risk for infection
  - Shorter ventilator dependency

- Cardiopulmonary bypass can be detrimental:
  - Systemic inflammatory response syndrome
    - Inflammatory activation by membrane oxygenator, heparin-coated circuits, UF
    - Ischemia-reperfusion injury to various organs (gut, kidneys, brain, etc)
  - Risk for adverse cerebral effects (cognitive decline)
  - Need for higher levels of anticoagulation
  - Need for cardiac standstill with cardioplegia and hypothermia

- Larger effective orifice area (EOA) with transcatheter vs surgical prostheses:
  - Less Patient-Prosthesis Mismatch (PPM)
  - PPM may be more important in low flow, low EF with heightened afterload sensitivity
Heart Failure
Leading cause of hospitalizations

Increased AFTERLOAD (sympathetic activity)
Impaired LV systolic function
Diastolic dysfunction

Beta-blockers
ACEI/ ARBs/ARNI
MRAs
Diuretics

Aortic Stenosis
Most frequent valvulopathy

Increased AFTERLOAD (trans-valvular gradient)
Impaired LV systolic function
Diastolic dysfunction

Coexistence of Heart Failure and Moderate Aortic Stenosis
High risk population
Early AVR may be beneficial

Moderate AS
Watchful Waiting

Severe AS
Aortic Valve Replacement

Prosthesis Patient Mismatch & EF

Dataset of 1266 patients - PPM in 38%

TAVR UNLOAD Concept

**Primary endpoint**

Hierarchical occurrence of

- All-cause death
- Disabling stroke
- Hospitalizations related to heart failure, aortic valve disease or non-disabling stroke
- Change in KCCQ

*To be analyzed with the Finkelstein-Schoenfeld method, 99% Power*  
If FS endpoint is statistically significant, proceed with MACCE endpoint, with sufficient (2-sided α = 0.05) power if 40% endpoints are reached

Spitzer et al. AHJ 2016;182:80-88
TAVR-UNLOAD Trial Design

Heart Failure
LVEF < 50%
NYHA ≥ 2
Optimal HF
therapy (OHFT)
Moderate AS

Follow-up:
1 month
6 months
1 year

Clinical Endpoints
Symptoms
Echo QoL

Primary Endpoint
Hierarchical occurrence of:
- All-cause death
- Disabling stroke
- Hospitalizations for HF, aortic valve
disease, or non-
- disabling stroke
- Change in KCCQ

Reduced AFTERLOAD
Improved LV systolic and diastolic function

TAVR UNLOAD Concept

Spitzer et al. AHJ 2016;182:80-88
Future of Transcatheter Aortic Therapies

- New Devices
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Fast Track

- Extreme example that demonstrates how far we have come

- Issues for early discharge include:
  - 2-night CMS rule
  - Transfer penalty
  - Unknown late risks of bleeding, conduction abnl
  - Role of medication changes, readmission rates
  - Utility for later in the day cases, home care
Fully Percutaneous Access

TAVR access: Annual breakdown of implanted patients

2017: >95% TF access
TF Completed with MAC or GA

First Quintile of Analysis (April to July 2014)

- April '14
- May '14
- June '14
- Jul '14

% MAC % GA

Last Quintile of Analysis (Jan to Mar. 2016)

- JAN 2016
- FEB 2016
- MAR 2016

% MAC % GA

2017: >90% Conscious

Original Studies

Rationale, Development, Implementation, and Initial Results of a Fast Track Protocol for Transfemoral Transcatheter Aortic Valve Replacement (TAVR)

Rebecca Marcantuono, MSN, CRNP, Jacob Gutsche, MD, Maureen Burke-Julien, MSN, CRNP, Saif Anwaruddin, MD, FSCAI, John G. Augoustides, MD, David Jones, MSN, CRNP, Lisa Mangino – Blanchard, MSN, CRNP, Nicole Hoke, MSN, RN, Stephanie Houseman, RN, Robert Li, MD, FSCAI, Prakash Patel, MD, Robert Stetson, MHA, Elizabeth Walsh, RN, Wilson Y. Szeto, MD, and Howard C. Herrmann, MD, FSCAI

Catheterization and Cardiovascular Interventions
Volume 85, Issue 4, pages 648–654, March 2015
Minimalist Experience at Emory University Hospital:
Reduced resource utilization, without compromising outcomes

### Standard Approach vs. Minimalist Approach

**Procedure Room Time**
- Standard Approach: 218 minutes
- Minimalist Approach: 150 minutes

**Intensive Care Unit Time**
- Standard Approach: 28 hours
- Minimalist Approach: 22 hours

**Length of Stay**
- Standard Approach: 5 days
- Minimalist Approach: 3 days

**Hospital Costs**
- Standard Approach: $55,300
- Minimalist Approach: $45,500

**Procedure Success**
- Standard Approach: 96%
- Minimalist Approach: 100%

**30-Day Mortality**
- Standard Approach: 6%
- Minimalist Approach: 0%

**Increase in MAC from 2014 to 2015**

Source: Babaliaros, V et al. “Comparison of Transfemoral Transcatheter Aortic Valve Replacement Performed in the Catheterization Laboratory (Minimalist Approach) Versus Hybrid Operating Room (Standard Approach)”. JACC 2014.
Goal

Identify subgroup of patients who could benefit from:

1. Early extubation
2. Fewer ICU days
3. Early ambulation

Fast Track Criteria

**Patient Characteristics**

- Easy airway management
- No severe lung disease
- LV EF > 40%
- PASP < 50 mmHg
- MR ≤ 2+
- eGFR > 60 ml/min
- STS risk < 8%
Results: Length of Stay and Direct Costs

**TABLE III**

<table>
<thead>
<tr>
<th></th>
<th>PT success</th>
<th>PT deviation</th>
<th>P</th>
<th>PT (all)</th>
<th>Standard care</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (n)</td>
<td>20</td>
<td></td>
<td>11</td>
<td>30</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>ICU LOS (h)</td>
<td>5.6 ± 6.3</td>
<td>85.8 ± 187.0</td>
<td>&lt;0.001</td>
<td>28.4 ± 102.8</td>
<td>44.8 ± 45.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Post-op LOS (days)</td>
<td>3.8 ± 3.1</td>
<td>5.5 ± 6.8</td>
<td>NS</td>
<td>4.3 ± 4.4</td>
<td>7.2 ± 5.3</td>
<td>&lt;0.001</td>
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<tr>
<td>Direct cost ($)</td>
<td>42,352 ± 7865</td>
<td>51,407 ± 23,968</td>
<td>0.003</td>
<td>44,907 ± 14,187</td>
<td>56,339 ± 12,808</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Monitored Anesthesia Care

- MAC Anesthetic
  - Distinguish from conscious sedation
  - MAC is a deeper level of sedation and higher level of care than conscious sedation
  - Now, the preferred approach for transfemoral TAVR at Penn i.e. MAC is first choice for all TF cases; must find reason for exclusion if choosing GA.
Anesthesia Exclusion Criteria

- Non-transfemoral approach
- Inability to lie flat / cooperate
- Potential difficult airway
- Morbid obesity
- Uncertain valve sizing where intraop TEE may be beneficial
- Any concerns for difficult access

Post-TAVR TTE

- Transthoracic echocardiogram performed after valve deployment (along with angiography)
  - Valve position and AR
  - Ventricular function
  - R/O pericardial effusion
- TTE service provided by trained echo technicians
Increase in MAC from 2014 to 2015

TAVR at Penn Today ≈ 450 Cases Annually

- Hybrid OR
- Heart team intact (Anesthesia, CV Surgery, Cardiology)
- MAC predominately (vs CS)
- Peripheral access (no PA catheter, no RIJ line)
- Percutaneous access
- Fast track to floor
- D/C home POD # 2-3
Estimated Global TAVR Procedure Growth

Global TAVR Procedures

TAVR procedures volumes will double globally in the next 4 years

TAVR at Penn Today ≈ 450 Cases Annually

- Hybrid OR
- Heart team intact (Anesthesia, CV Surgery, Cardiology)
- MAC predominately (vs CS)
- Peripheral access (no PA catheter, no RIJ line)
- Percutaneous access
- Fast track to floor
- D/C home POD # 2-3
Conversion Rates

- Rare to convert from MAC to GA
- Literature reports 4.6%
- Since April 2014:
  - Planned MAC for TF closure
  - Converted MAC to GA
  - $16/309 = 5.2\%$
- Vascular/femoral cutdown; hemodynamic instability; inadequate sedation/over-sedation

Incidence of CVA after TAVI remains clinically significant, particularly in high risk patients

New cerebral lesions are found in the vast majority of patients following TAVI

- 68-100% of TAVI patients affected1-11
- Most patients have multiple infarcts
- “Silent” infarcts associated with12-14
  - 2-4-fold risk of future stroke
  - >3-fold risk of mortality
  - >2-fold risk of dementia
  - Cognitive decline
  - Dementia

Ghanem, et al, JACC 2010
Kahlert, et al., Circulation. 2010;121:870-878
Astarci, et al., EJCTS 2011; 40:475-9
Lansky, et al., EHJ 2015; May 19
Linke, et al., TCT 2014

6. Lansky, et al., EHJ 2015; May 19
8. Linke, et al., TCT 2014
9. Vahanian, TCT 2014
12. Sacco et al., Stroke 2013
13. Vermeer et al., Stroke 2003
Background

- The Claret Montage™ dual-filter Cerebral Protection System was developed to protect the brain from injury caused by embolic debris.
- Randomized controlled trial data showing the efficacy of any embolic protection device in TAVR are missing.
SENTINAL TRIAL: Primary Efficacy Endpoint

42.2% reduction [95% CI: -3.2, 67.6]  

\[ p = 0.33 \]

New Lesion Volume in Protected Territories (mm³)

Control \( N=98 \)

Median ± 95% Confidence Limit

Treatment \( N=91 \)

102.8

178

Valve Leaflet Abnormalities

Makkar, et al. 2015
TAVR Adjunct Pharmacology
Customized Patient-Based Therapy

BEFORE -
Acetylsalicylic acid (ASA)

DURING
UNFRACTIONATED HEPARIN:
target ACT ≥300*

Bivalirudin: BRAVO
Low Molecular Weight Heparin

AFTER
ASA + CLOPIDOGREL
Acetylsalicylic acid (ASA)
ARTE trial
Non anti-VKA Oral Anticoagulant ± ASA:

New TAVR Pharmacology Trial

Prospective, randomized, open-label with blinded endpoint evaluation (PROBE), parallel-group, active-controlled, multicenter international study

Pls: Dangas, G.
Windecker, S.
US Pl: Herrmann, H.
PowerPoint Timesaver: Charts, tables, diagrams, icons, and more

Date

Bar charts: Tornado

Chart title runs here (units)

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<td>4.5</td>
<td>4.0</td>
<td>3.5</td>
<td>3.0</td>
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<td>2.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Notes:

Sources:
Vital Components to a Successful Transcatheter Program

Team Work

HUP Physicians:
- Cardiothoracic Surgeons
- Interventional Cardiologists
- Echocardiologists
- CT anesthesiologists
- Outside Referring Physicians
- Hybrid OR Staff
- ICU Nurses
- Research Coordinators
- Sponsoring Company
- Patient Families

“It Takes a Village!”