Top 10 Advances in Transcatheter Valve Therapy 2019

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Mount Sinai Hospital, NY

COI: Speaker bureau for Abbott, BSC, CSI
The Future of Transcatheter Heart Valves

Aortic Valve
Medtronic CoreValve

Mitral Valve
Edwards Sapien XT

Tricuspid Valve
Edwards Perimount Magna

Pulmonic Valve
Medtronic Melody Valve
The Andersen Stent-Valve (1989)
Father of Transcatheter Valve Therapy

Percutaneous Valve Technologies (PVT) Aortic Heart Valve

Bovine pericardium / Stainless steel stent

23mm max diameter

24F

Conclusions: Nonsurgical implantation of a prosthetic heart valve can be safely and successfully achieved with immediate & midterm results

Alain Cribier

FIM: April 16, 2002
# Stages of Progression of Valvular Heart Disease (VHD)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At risk</td>
<td>Patients with risk of development of VHD</td>
</tr>
<tr>
<td>B</td>
<td>Progressive</td>
<td>Patients with progressive VHD (mild-moderate severity and asymptomatic)</td>
</tr>
</tbody>
</table>
| C     | Asymptomatic severe | Asymptomatic patients who have the criteria for severe VHD:  
C1: Asymptomatic patients with severe VHD in whom the left or right ventricle remains compensated  
C2: Asymptomatic patients with severe VHD, with decompensation of the left or right ventricle |
| D     | Symptomatic severe | Patients who have developed symptoms as a result of VHD |
Reasons for selection of the study

Revolutionary / significant observation

Widespread acceptance

Change in clinical practice
10. Tricuspid Valve Intervention
Transcatheter Tricuspid Landscape

Coaptation Devices

Suture Annuloplasty

Heterotopic Caval Valve Implant

Ring Annuloplasty

Transcatheter Tricuspid Valve Replacement

Asmarats et al., J Am Coll Cardiol 2018;71:2935
Long-Term Outcomes of the FORMA Transcatheter Tricuspid Valve Repair System for the Treatment of Severe Tricuspid Regurgitation

Insights From the First-in-Human Experience

Lluis Asmarats, MD, a,∗ Gidon Perlman, MD, b,c,∗ Fabien Praz, MD, d Mark Hensey, MB, BCH, BAO, b Michael P. Chrissoheris, MD, e Francois Philippon, MD, a Hadass Ofek, MD, b Jian Ye, MD, b Rishi Puri, MBBS, PhD, a,f,g Philippe Pibarot, DVM, PhD, a Adrian Attinger, MD, b Robert Moss, MD, b Elisabeth Bédard, MD, a Aris Moschovitis, MD, d David Reineke, MD, d Sandra Lauck, PhD, b Philipp Blanke, MD, b Jonathon Leipsic, MD, b Konstantinos Spargias, MD, e Stephan Windecker, MD, d John G. Webb, MD, b Josep Rodés-Cabau, MD a
Serial Echocardiographic Changes: Changes in TR Severity Overtime

- Rate of TR significantly reduced from 95% at baseline to 33% at 2-3 yr FU ($p<0.001$)
- TR remained moderate to less at last FU

- Significant reduction of VC width at 24- to 36-month FU (11.8 – 8.4 mm; $p=0.005$)
- No significant changes in EROA (0.92 vs 0.77 cm$^2$; $p=0.52$

Asmarats et al., J Am Coll Cardiol Intv 2019;12:1438
Long-Term Outcomes of the FORMA Transcatheter Tricuspid Valve Repair System for the Treatment of Severe Tricuspid Regurgitation

Insights From the First-in-Human Experience

CONCLUSIONS TTVr using the FORMA system showed favorable long-term safety profile in high-surgical-risk patients, with sustained functional improvement and acceptable TR reduction up to 3 years. (J Am Coll Cardiol Intv 2019;12:1438-47) © 2019 by the American College of Cardiology Foundation.
1-Year Outcomes After Edge-to-Edge Valve Repair for Symptomatic Tricuspid Regurgitation

Results From the TriValve Registry

Michael Mehr, MD, a,b,*, Maurizio Taramasso, MD, c,*, Christian Besler, MD, d Tobias Ruf, MD, e Kim A. Connelly, MD, f Marcel Weber, MD, g Ermela Yzeiraj, MD, h Davide Schiavi, MD, i Antonio Mangieri, MD, j Laura Vaskelyte, MD, j Hannes Alessandrini, MD, k Florian Deuschl, MD, l Nicolas Brugger, MD, m Hasan Ahmad, MD, n Luigi Biasco, MD, o Mathias Orban, MD, a,b Simon Deseive, MD, a,b Daniel Braun, MD, a,b Karl-Philipp Rommel, MD, d Alberto Pozzoli, MD, c Christian Frerker, MD, k Michael Näbauer, MD, a,b Steffen Massberg, MD, a,b Giovanni Pedrazzini, MD, o Gilbert H.L. Tang, MD, n,p Stephan Windecker, MD, m Ulrich Schäfer, MD, l Karl-Heinz Kuck, MD, k Horst Sievert, MD, j Paolo Denti, MD, l Azeem Latib, MD, l Joachim Schofer, MD, h Georg Nickenig, MD, g Neil Fam, MD, f Stephan von Bardeleben, MD, e Philipp Lurz, MD, d Francesco Maisano, MD, c,† Jörg Hausleiter, MD a,b,†
TriValve Registry: Procedural Results

TR and NYHA Class Over Time

- Significant reduction in TR between baseline and post-procedure (p<0.001) and no difference between post-procedure and last-follow up (p=0.89)
- Significant improvement (p<0.001) for NYHA functional class at baseline and at follow-up; there was down-grading of at least 1 NYHA functional class in 72% of cases

Mortality According to Procedural Success

- Mortality at 1 year, stratified for:
  - procedural success (17.0%; 95% CI: 10.6% - 23.0%)
  - procedural failure (30.8%; 95% CI: 16.2% - 42.9%)

*Mehr et al., J Am Coll Cardiol Intv 2019;12:1451*
TRILUMINATE Trial: TriClip System
TRILUMINATE TriClip Study

- Prospective, single-arm, multicenter feasibility study
- At least 85 patients in 15 centers (4 in US 35 patients: Mount Sinai, Henry Ford, Abbott Northwestern, Cedar Sinai)
- Moderate or greater TR in NYHA II, III, ambulatory IV
- Follow-up to 3 years

**Primary Endpoint:** TR reduction ≥ 1 grade at 30d

**Secondary Endpoint:** Cardiac mortality at 30d

PI: G Tang MD

Total: 30 cases
MSH: 7 cases
Summary of Ongoing and Future Studies on Transcatheter Therapies for Tricuspid Regurgitation

<table>
<thead>
<tr>
<th>Device</th>
<th>Study</th>
<th>Study Design</th>
<th>Patients</th>
<th>Primary Endpoints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forma</td>
<td>SPACER (NCT02787408)</td>
<td>Prospective registry</td>
<td>78</td>
<td>Safety: cardiac mortality at 30 days, compared with a research-derived performance goal based on high-risk surgical outcomes for tricuspid repair/replacement</td>
</tr>
<tr>
<td>Early Feasibility Study of the Edwards Forma Tricuspid Transcatheter Repair System (NCT02471807)</td>
<td>Prospective registry</td>
<td>30</td>
<td>Procedural success defined as device success and freedom from device- or procedure-related SAEs at 30 days</td>
<td></td>
</tr>
<tr>
<td>MitraClip</td>
<td>TRILLUMINATE (NCT03227757)</td>
<td>Prospective registry</td>
<td>75</td>
<td>Echocardiographic tricuspid regurgitation reduction at least 1 grade (30 days) Composite of MAE (6 months)</td>
</tr>
<tr>
<td>MitraClip for Severe TR (NCT02863549)</td>
<td>Prospective registry</td>
<td>100</td>
<td>Tricuspid regurgitation grade and incidence of major adverse cerebrovascular events (1-12 months)</td>
<td></td>
</tr>
<tr>
<td>Trialign</td>
<td>SCOUT II (NCT03225612)</td>
<td>Prospective registry</td>
<td>60</td>
<td>All-cause mortality at 30 days</td>
</tr>
<tr>
<td>Early feasibility of the Mitralign PTVAS, also known as Trialign (NCT02574650)</td>
<td>Prospective registry</td>
<td>30</td>
<td>Technical success at 30 days, defined as freedom from death with successful access, delivery and retrieval of the device delivery system, and deployment and correct positioning of the intended device, and no need for additional unplanned or emergency surgery or reintervention related to the device or access procedure</td>
<td></td>
</tr>
<tr>
<td>TriCinch</td>
<td>PREVENT (NCT02098200)</td>
<td>Prospective registry</td>
<td>24</td>
<td>Safety: participants with MAE* within 30 days of the procedure</td>
</tr>
<tr>
<td>Clinical Trial Evaluation of the Percutaneous 4Tech TriCinch Coil Tricuspid Valve Repair System (NCT03239420D)</td>
<td>Prospective registry</td>
<td>90</td>
<td>Efficacy: reduction of tricuspid regurgitation by at least 1 degree immediately after the procedure and at discharge</td>
<td></td>
</tr>
<tr>
<td>MIA</td>
<td>STTAR (not registered)</td>
<td>Prospective registry</td>
<td>40</td>
<td>All-cause mortality of the per protocol cohort at 30 days post-procedure</td>
</tr>
<tr>
<td>Cardioband</td>
<td>TRI-REPAIR (NCT02981953)</td>
<td>Prospective registry</td>
<td>30</td>
<td>Overall rate of major SAEs and serious adverse device effects at 30 days</td>
</tr>
<tr>
<td>Edwards Cardioband Tricuspid Valve Reconstruction System Early Feasibility Study (NCT03382457)</td>
<td>Prospective registry</td>
<td>15</td>
<td>Intraprocedural successful access, deployment and positioning of the Cardioband device and septolateral diameter reduction</td>
<td></td>
</tr>
<tr>
<td>Change in septolateral dimension at 30 days</td>
<td>Freedom from device or procedure-related adverse events (30 days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterotopic CAVI</td>
<td>HOVER (NCT02339974)</td>
<td>Prospective registry</td>
<td>15</td>
<td>Procedural success at 30 days, defined as device success and no SAE!</td>
</tr>
<tr>
<td>Individual success at 30 days, defined by device success and positive clinical outcomes!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRICAVAL (NCT02387697)</td>
<td>Randomized open-label</td>
<td>40</td>
<td>Maximum relative VO₂ at 3 mo (difference of means in maximum relative VO₂ at 3 months compared with control group)</td>
<td></td>
</tr>
</tbody>
</table>
Top 10 Advances in Transcatheter Valve Therapy 2019

1. Alternate Access for TAVR

2.

3.

4.

5.

6.

7.

8.

9. Alternate Access for TAVR

10. Tricuspid Valve Intervention
Overview of the Alternative Approaches

- Transcarotid
- Transaortic
- Transseptal
- Transcaval
- Transsubclavian
- Transapical
- Transfemoral
- Iliac artery

Percutaneous PTA
Cutdown
IVL
Timing of Published Cohorts Regarding Alternative Approaches for TAVI and Relative Experience with Respect to the Abundance of Data of Each Alternative Approach
Intra Vascular Lithotripsy (IVL) Can Crack the Calcium in Peripheral Vessels

When the waves come in contact with calcium they create a series of micro-fractures in the plaque via high transient shear pressure and various shear mechanisms.
A Prospective Registry of Intravascular Lithotripsy-Enabled Vascular Access for Transfemoral Transcatheter Aortic Valve Replacement

Carlo Di Mario, Mark Goodwin, Francesca Ristalli, Marcello Ravani, Francesco Meucci, Miroslava Stolcova, Gennaro Sardella, Nicolo Salvi, Francesco Bedogni, Sergio Berti, Vasilis C. Babaliaros, Andrei Pop, David Caparrelli, James Stewart and Chandan Devireddy
First Prospective Registry of Shockwave in TF TAVR Pts

\( N=42; \) 47 lesions

- All patients achieved successful sheath passage and TAVR
- Femoral access was achieved percutaneously in \( >90\% \) of patients
- Reference vessel diameter was 8.1 mm, lesion minimum diameter 4.3 mm, with average stenosis of 58.6%.
- The majority of IVL was performed with a 7-mm catheter (84.6%).
- No iliofemoral arterial perforation or dissection requiring stent implantation was observed.
- Vascular hemostasis was achieved with percutaneous sutures \( >90\% \) of the time.
- Access site complications were low (4.6%) with 1 patient developing pseudoaneurysm and 1 requiring endarterectomy.
Comparison of Transaortcic and Subclavian Approaches for Transcatheter Aortic Valve Replacement in Patients with No Transfemoral Access Options

Asaad A. Khan, MD, Jason C. Kovacic, MD, PhD, Krysthel Engstrom, MD, Allan Stewart, MD, Anelechi Anyanwu, MD, Sandeep Basnet, MD, Melissa Aquino, MS, Usman Baber, MD, Luis Garcia, MD, Umesh Gidwani, MD, George Dangas, MD, PhD, Annapoorna Kini, MD, and Samin Sharma, MD

Mortality Difference Between TAo and SCL Approaches at 1 Year Post TAVR

**Results:** A total of 27 (53%) patients underwent TAVR via the TAo approach and 24 (47%) via the SCL approach. Society of Thoracic Surgeons (STS) risk scores and patient age were similar: 11.33 versus 8.66; \( p = 0.13 \) and 84.7 years versus 82.6 years; \( p = 0.3 \), respectively. All patients in the SCL group received self-expandable valves. Overall vascular complications were low in both groups (SCL = 4.2% vs. TAo = 3.7%). Length of hospital stay was marginally longer in the TAo group (mean 7.25 vs. 6.2 days, \( p = 0.119 \)). There was a trend towards increased mortality associated with TA access (11.1% vs. 4%, \( p = 0.36 \)) at 30 days that was significant after 12 months (33.3% vs. 8.3%, \( p = 0.03 \)).
Transcaval Access Technique for TAVR

A. Transcaval access obtained over an electrified guidewire

B. Microcatheter delivered to exchange for a stiff guidewire

C. Transcathter heart valve introducer sheath is advanced

D. Aorto-caval access site is closed with nitinol cardiac occluder

Greenbaum et al., J Am Coll Cardiol 2017;69:511
### Procedure Characteristics (N=100)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Valve-in-valve&quot; TAVR</td>
<td>6</td>
</tr>
<tr>
<td>Crossing duration, from snare to introducer sheath, min</td>
<td>21.1 ± 17.5</td>
</tr>
<tr>
<td>Need for tract balloon dilatation after initial guidewire crossing</td>
<td>40</td>
</tr>
</tbody>
</table>
| Valve type | Edwards Sapien XT (n = 23)  
              Edwards Sapien 3 (n = 57)  
              Medtronic Corevalve (n = 11)  
              Medtronic Corevalve Evolut R (n = 9) |
| Valve size nominal, mm | 20 (n = 3)  
                          23 (n = 37)  
                          26 (n = 41)  
                          29 (n = 19) |
| Sheath model | Edwards Retroflex 3 (n = 6)  
              Edwards eSheath (n = 73)  
              Cook Large Check-Flo (n = 13)  
              Cook Extra-Large Check-Flo (n = 8) |
| Sheath outer diameter, mm | 8.0 ± 0.7 |
| TAVR success | 100% |
| Closure duration, from introducing device to completion angiogram (min) | 14.1 ± 9.5 |
| Closure device | ADO (n = 58)  
                 VSD (n = 40)  
                 None (n = 2) |
| Final closure device size | Amplatzer Duct Occluder (n = 58)  
                           8/6 mm (n = 7); 10/8 mm (n = 51)  
                           Amplatzer Muscular VSD Occluder (n = 40)  
                           6 mm (n = 10); 8 mm (n = 27); 10 mm (n = 3)  
                           Covered stent only (n = 1) |
| Angiographic closure score | 1.0 ± 0.8 |
| Adjunctive balloon aortic tamponade | 17 |
| Total contrast volume (ml) | 166 ± 87 |
| Anesthesia technique | General anesthesia with endotracheal intubation (n = 84) (52 [62%] extubated on-table); moderate sedation (n = 16) |

### Outcomes Through 30 Days (N=100)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Count</th>
</tr>
</thead>
</table>
| Death within 30 days | 7 Cardiovascular  
                         1 Noncardiovascular |
| Stroke | 5 Ischemic  
         2 Peri-procedural |
| Myocardial infarction | 2 |
| Contrast nephropathy requiring dialysis | 2 |
| Acute kidney injury classification | Grade 0 (n = 87)  
                                    Grade 1 (n = 9)  
                                    Grade 2 (n = 0)  
                                    Grade 3 (n = 3) |
| Thrombocytopenia <50 x 10^3 / μl | 5 (4 with patent fistula) |
| Non-access-related bleeding (e.g., gastrointestinal) | 15 |
| Transfusion during TAVR/after TAVR/during or after TAVR | 14/30/35 |
| Transfusion units among those transfused (median) (n = 35/100) | 2.0 (2.0, 4.0) |
| Follow-up CT scan before discharge | 87 |
| Post-TAVR length of stay (days), median (quartiles) | 4 (2-6) |
| Post-TAVR intensive care unit length of stay (days), median (quartiles) | 1 (1-3) |
| VARC-2 composite early safety | 75 |
Transcarotid Approach for Transcatheter Aortic Valve Replacement With the Sapien 3 Prosthesis

A Multicenter French Registry

Pavel Overtchouk, MD, Thierry Folliguet, MD, PhD, Frédéric Pinaud, MD, PhD, Oliver Fouquet, MD, Mathieu Pernot, MD, Guillaume Bonnet, MD, Maxime Hubert, MD, Joël Lapeze, MD, Jean Philippe Claudel, MD, Said Ghostine, MD, Alexandre Azmoun, MD, Christophe Caussin, MD, Konstantinos Zannis, MD, Majid Harmouche, MD, Jean-Philippe Verhoye, MD, PhD, Antoine Lafont, MD, PhD, Chekrallah Chamandi, MD, Vito Giovanni Ruggieri, MD, PhD, Alessandro Di Cesare, MD, Florence Leclercq, MD, PhD, Thomas Gandet, MD, Thomas Modine, MD
Trans-carotid TAVR: Survival Curve

Overtchouk et al., J Am Coll Cardiol Intv 2019;12:413

Trans-carotid TAVR: Clinical Outcomes

<table>
<thead>
<tr>
<th>Reason</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>General anesthesia</td>
<td>286</td>
<td>91.1</td>
</tr>
<tr>
<td>Pre-implant balloon valvuloplasty</td>
<td>115</td>
<td>36.6</td>
</tr>
<tr>
<td>Post-implant balloon valvuloplasty</td>
<td>45</td>
<td>14.3</td>
</tr>
<tr>
<td>Left carotid</td>
<td>231</td>
<td>73.6</td>
</tr>
<tr>
<td><strong>Prosthesis size (mm)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td>23</td>
<td>83</td>
<td>26.4</td>
</tr>
<tr>
<td>26</td>
<td>147</td>
<td>46.8</td>
</tr>
<tr>
<td>29</td>
<td>82</td>
<td>26.1</td>
</tr>
<tr>
<td><strong>Procedural success</strong></td>
<td>305</td>
<td>97.1</td>
</tr>
<tr>
<td><strong>Reasons for procedural failure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve-in-valve</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>Annulus rupture</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>Conversion to open surgery</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td>Left-ventricle perforation</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Procedural mortality</strong></td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>STEMI</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Tamponade</strong></td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>Valve malpositioning</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Major vascular complication</td>
<td>5</td>
<td>1.6</td>
</tr>
<tr>
<td>Major bleeding</td>
<td>13</td>
<td>4.1</td>
</tr>
<tr>
<td>Moderate to severe PVL on TTE</td>
<td>16</td>
<td>5.1</td>
</tr>
<tr>
<td>Post-implant echocardiographic mean gradient (mm Hg)</td>
<td>11 (8-13)</td>
<td></td>
</tr>
<tr>
<td>New permanent pacemaker</td>
<td>51</td>
<td>16.2</td>
</tr>
<tr>
<td>Stroke/TIA (30 days)</td>
<td>5</td>
<td>1.6</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>7</td>
<td>5-10</td>
</tr>
<tr>
<td>Mortality (30 days)</td>
<td>10</td>
<td>3.2</td>
</tr>
</tbody>
</table>
Trans-carotid TAVR: 30-Day Clinical Results

STS Mortality Risk Score – 5.8%

Overtchouk et al., J Am Coll Cardiol Intv 2019;12:413
Comparative 30-Day In-Hospital Outcomes of Different Access Routes for TAVR According to the VARC Definition

Pranz et al., Circ Cardiovasc Interv 2018;11:e007459
Transcatheter Aortic Valve Replacement via the Transcarotid Access: The Best Alternative?

Fabien Praz, MD; Peter Wenaweser, MD
TAVR: Proposed Algorithm for Alternative Approach Selection

1. Patient eligible to TAVR
2. TF access favorable
   - Yes: TF TAVR
   - No
     - Carotid and vertebral artery patency
       - Functioning Willis circle
     - Patient anatomy
       - Local expertise
     - No previous mammal CABG
       - Subclavian artery patency
     - No previous venous CABG

3. TAo access
   - Transcarotid access
   - Transsubclavian access

4. TC, TAo, TS approaches precluded
5. Consider TA access

Transcaval access
Top 10 Advances in Transcatheter Valve Therapy 2019

8. Antithrombotic Therapy post TAVR
9. Alternate Access for TAVR
10. Tricuspid Valve Intervention
Optimal Antithrombotic Treatment After TAVR

- **AT+**
  - Bleeding Risk
  - Thrombo-embolic Risk
  - Mortality

- **AT-**
  - Structural Valve Deterioration

**OAC-based strategy**
(VKA or NOAC)

**DAPT**
(ASA+Clopidogrel)

**SAPT**
(ASA or Clopidogrel alone)

Empirically Aspirin 81mg lifelong and Clopidogrel 75mg daily for 3-6M is recommended
<table>
<thead>
<tr>
<th>Study</th>
<th>Treatment Comparison</th>
<th>Number of Patients</th>
<th>NVAF</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>GALILEO</td>
<td>RIVA vs DAPT/SAPT</td>
<td>1520</td>
<td>Excluded</td>
<td>Enrolment completed</td>
</tr>
<tr>
<td>ATLANTIS</td>
<td>VKA vs Apixaban DAPT/SAPT vs Apixaban</td>
<td>1510</td>
<td>Included (stratified)</td>
<td>Enrolment almost done</td>
</tr>
<tr>
<td>ENVISAGE</td>
<td>EDOXABAN</td>
<td>1400</td>
<td>only</td>
<td>Ongoing</td>
</tr>
<tr>
<td>POPULAR</td>
<td>VKA vs VKA+clopi DAPT vs ASA</td>
<td>1510</td>
<td>Included and stratified</td>
<td>Ongoing</td>
</tr>
<tr>
<td>AVATAR</td>
<td>VKA vs VKA+APT</td>
<td>170</td>
<td>Included (stratified)</td>
<td>Ongoing</td>
</tr>
<tr>
<td>AUREA</td>
<td>VKA vs DAPT</td>
<td>124</td>
<td>Excluded</td>
<td>Ongoing</td>
</tr>
</tbody>
</table>
Prospective, randomized, open-label with blinded endpoint evaluation (PROBE), parallel-group, active-controlled, multicenter international study

**Study population:**
Patients with successful TAVR *

**Key excl. criteria:**
- Ongoing indication for DAPT or anticoagulation
- Previous ischemic stroke, active peptic ulcer or upper GI bleeding
- Previous ICH, or severe renal insufficiency

Rivaroxaban 10 mg OD + ASA 75–100 mg

Rivaroxaban 10 mg OD

N=1,520

3 months: drop one antplatelet

18 months (12–24 months)

Trial completed enrollment as of April 2018

August 2018, DSMB recommended to halt the study follow-up due to safety concerns; Higher mortality?

* About 110 sites in Europe & North America (15 countries)

** Majority of patients will be on DAPT after TAVR**
Gastric protection recommended throughout study
A Controlled Trial of Rivaroxaban after Transcatheter Aortic-Valve Replacement

GALILEO: Screening, Randomization, and Follow-Up

1674 Patients were assessed for eligibility

- 30 Provided consent but did not undergo randomization
  - 1 Had adverse event
  - 17 Had screening failure
  - 6 Withdrawn
  - 6 Had other reason

1644 Underwent randomization

826 Were assigned to the rivaroxaban group
  - 801 (97.0%) Received rivaroxaban
  - 25 (3.0%) Did not receive rivaroxaban

818 Were assigned to the antiplatelet group
  - 807 (98.7%) Received antiplatelet drug
  - 11 (1.3%) Did not receive antiplatelet drug

- 27 (3.3%) Did not complete trial
  - 1 (0.1%) Had adverse event
  - 21 (2.5%) Withdrew consent
  - 5 (0.6%) Were lost to follow-up

799 (96.7%) Completed trial

- 26 (3.2%) Did not complete trial
  - 21 (2.6%) Withdrew consent
  - 5 (0.6%) Were lost to follow-up

792 (96.8%) Completed trial

GALILEO Trial: Primary Efficacy and Safety Endpoints At 2-Yr Follow-Up

## GALILEO Trial: Efficacy and Safety Outcomes (ITT)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Rivaroxaban Group (N = 826)</th>
<th></th>
<th>Antiplatelet Group (N = 818)</th>
<th></th>
<th>Difference (95% CI)</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no. (%) incidence rate/100 person-yr</td>
<td>no. (%) incidence rate/100 person-yr</td>
<td></td>
<td>incidence rate/100 person-yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Efficacy outcomes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary efficacy outcome</td>
<td>105 (12.7) 9.8</td>
<td>78 (9.5) 7.2</td>
<td>2.6 (0.1 to 5.1)</td>
<td>1.35 (1.01 to 1.81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td>64 (7.7) 5.8</td>
<td>38 (4.6) 3.4</td>
<td>2.4 (0.6 to 4.1)</td>
<td>1.69 (1.13 to 2.53)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From cardiovascular causes</td>
<td>35 (4.2) 3.2</td>
<td>27 (3.3) 2.4</td>
<td>0.7 (0.7 to 2.1)</td>
<td>1.30 (0.79 to 2.14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From noncardiovascular causes</td>
<td>29 (3.5) 2.6</td>
<td>11 (1.3) 1.0</td>
<td>1.6 (0.5 to 2.7)</td>
<td>2.67 (1.33 to 5.35)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>30 (3.6) 2.8</td>
<td>25 (3.1) 2.3</td>
<td>0.5 (0.8 to 1.8)</td>
<td>1.20 (0.71 to 2.05)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischemic</td>
<td>28 (3.4) 2.6</td>
<td>22 (2.7) 2.0</td>
<td>0.6 (0.7 to 1.8)</td>
<td>1.28 (0.73 to 2.23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemorrhagic</td>
<td>2 (0.2) 0.2</td>
<td>3 (0.4) 0.3</td>
<td>-0.1 (0.5 to 0.3)</td>
<td>0.67 (0.11 to 3.98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>23 (2.8) 2.1</td>
<td>17 (2.1) 1.5</td>
<td>0.6 (0.6 to 1.7)</td>
<td>1.37 (0.73 to 2.56)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptomatic valve thrombosis</td>
<td>3 (0.4) 0.3</td>
<td>7 (0.9) 0.6</td>
<td>-0.4 (0.9 to 0.2)</td>
<td>0.43 (0.11 to 1.66)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>3 (0.4) 0.3</td>
<td>2 (0.2) 0.2</td>
<td>0.1 (0.3 to 0.5)</td>
<td>1.49 (0.25 to 8.93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep-vein thrombosis</td>
<td>1 (0.1) 0.1</td>
<td>4 (0.5) 0.4</td>
<td>-0.3 (0.7 to 0.1)</td>
<td>0.25 (0.03 to 2.23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systemic embolism</td>
<td>1 (0.1) 0.1</td>
<td>1 (0.1) 0.1</td>
<td>-0.0 (0.3 to 0.3)</td>
<td>0.98 (0.06 to 15.69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Key secondary efficacy outcome</strong></td>
<td>83 (10.0) 7.8</td>
<td>68 (8.3) 6.3</td>
<td>1.5 (0.8 to 3.7)</td>
<td>1.22 (0.89 to 1.69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net clinical benefit</strong></td>
<td>137 (16.6) 13.2</td>
<td>100 (12.2) 9.4</td>
<td>3.8 (0.9 to 6.7)</td>
<td>1.39 (1.08 to 1.80)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety outcomes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary safety outcome</td>
<td>46 (5.6) 4.3</td>
<td>31 (3.8) 2.8</td>
<td>1.5 (0.1 to 3.1)</td>
<td>1.50 (0.95 to 2.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAREC life-threatening or disabling bleeding</td>
<td>18 (2.2) 1.6</td>
<td>17 (2.1) 1.5</td>
<td>0.1 (-1.0 to 1.2)</td>
<td>1.06 (0.55 to 2.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatal bleeding</td>
<td>2 (0.2) 0.2</td>
<td>1 (0.1) 0.1</td>
<td>0.1 (0.2 to 0.4)</td>
<td>2.01 (0.18 to 22.19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VARC major bleeding</td>
<td>30 (3.6) 2.8</td>
<td>15 (1.8) 1.4</td>
<td>1.4 (0.2 to 2.6)</td>
<td>2.02 (1.09 to 3.76)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIMI major or minor bleeding</td>
<td>42 (5.1) 3.9</td>
<td>24 (2.9) 2.2</td>
<td>1.7 (0.3 to 3.2)</td>
<td>1.78 (1.08 to 2.94)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISTH major bleeding</td>
<td>49 (5.9) 4.6</td>
<td>30 (3.7) 2.7</td>
<td>1.9 (0.2 to 3.5)</td>
<td>1.66 (1.05 to 2.62)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BARC type 2, 3, or 5 bleeding</td>
<td>148 (17.9) 15.4</td>
<td>85 (10.4) 8.2</td>
<td>7.2 (4.2 to 10.3)</td>
<td>1.84 (1.41 to 2.41)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The primary efficacy endpoint of the trial is a composite of all-cause death, stroke, systemic embolism, MI, pulmonary embolism, DVT, or symptomatic valve thrombosis. The primary safety endpoint is a composite of life-threatening or disabling bleeding (BARC types 5 and 3b/3c) or major bleeding (BARC type 3a).

**Rivaroxaban group (n=826)**
- Rivaroxaban 10 mg + aspirin 75-100 mg for 90 days, maintenance 10 mg rivaroxaban

**Antiplatelet group (n=818)**
- Aspirin 75-100 mg + 75 mg clopidogrel for 90 days, followed by aspirin monotherapy
Top 10 Advances in Transcatheter Valve Therapy 2019

7. TAVR Leaflet Durability Studies
8. Antithrombotic Therapy post TAVR
9. Alternate Access for TAVR
10. Newer Large Bore Access Devices
Reduced Leaflet Motion after Transcatheter Aortic-Valve Replacement

Ole De Backer, M.D., Ph.D., George D. Dangas, M.D., Hasan Jilaihawi, M.D., Jonathon A. Leipsic, M.D., Christian J. Terkelsen, M.D., D.M.Sc., Ph.D., Raj Makkar, M.D., Annapoorna S. Kini, M.D., Karsten T. Veien, M.D., Mohamed Abdel-Wahab, M.D., Ph.D., Won-Keun Kim, M.D., Prakash Balan, M.D., Nicolas Van Mieghem, M.D., Ph.D., Ole N. Mathiassen, M.D., Ph.D., Raban V. Jeger, M.D., Martin Arnold, M.D., Roxana Mehran, M.D., Ana H.C. Guimarães, Ph.D., Bjarne L. Nørgaard, M.D., Ph.D., Klaus F. Kofoed, M.D., D.M.Sc., Philipp Blanke, M.D., Stephan Windecker, M.D., and Lars Søndergaard, M.D., D.M.Sc., for the GALILEO-4D Investigators*
GALILEO 4D: 4D CT Imaging

GALILEO 4D: Study Endpoints

Primary endpoint
• The proportion of patients with at least one prosthetic valve leaflet with reduced leaflet motion (RLM) ≥ grade 3

Secondary endpoints
• The proportion of patients with at least one thickened leaflet (HALT)
• The proportion of valve leaflets with HALT or RLM ≥ grade 3
• Transprosthetic mean pressure gradient (TTE)
• Safety and efficacy outcomes identical to main GALILEO trial

GALILEO 4D: 4DCT outcomes

<table>
<thead>
<tr>
<th>Reduced leaflet motion (RLM)</th>
<th>Rivaroxaban (N=97)</th>
<th>Antiplatelet (N=101)</th>
<th>Δ proportions (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis at patient level</td>
<td>2.1%</td>
<td>10.9%</td>
<td>-8.8% (-16.5 to -1.9%)</td>
</tr>
<tr>
<td>At least one leaflet with RLM grade ≥ 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis at leaflet level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rivaroxaban (N=291)</td>
<td>1.0%</td>
<td>4.6%</td>
<td>-3.6% (-6.7 to -0.9%)</td>
</tr>
<tr>
<td>Number of leaflets with RLM grade ≥ 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leaflet thickening (HALT)</th>
<th>Rivaroxaban (N=97)</th>
<th>Antiplatelet (N=102)</th>
<th>Δ proportions (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis at patient level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least one thickened leaflet</td>
<td>12.4%</td>
<td>32.4%</td>
<td>-20.0% (-30.9 to -8.5%)</td>
</tr>
<tr>
<td>Analysis at leaflet level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rivaroxaban (N=291)</td>
<td>5.5%</td>
<td>17.3%</td>
<td>-11.8% (-16.9 to -6.8%)</td>
</tr>
<tr>
<td>Number of leaflets with thickening</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GALILEO 4D: Reduced Leaflet Motion and Leaflet Thickening- ITT/PP Analysis

**Intention-to-treat (ITT)**

- Reduced leaflet motion ≥ grade 3
- Leaflet thickening

**Per-protocol (PP)**

- Reduced leaflet motion ≥ grade 3
- Leaflet thickening

*De Backer et al., N Engl J Med 2019 Nov 16 Epub ahead of print*
PARTNER 3 Low-Risk Computed Tomography (CT) Sub-study: Subclinical Leaflet Thrombosis in Transcatheter and Surgical Bioprosthetic Valves
PARTNER 3: Background

Subclinical Leaflet Thrombosis characterized by hypo-attenuated leaflet thickening (HALT) and reduced leaflet motion has been frequently observed in transcatheter and surgical aortic bioprosthetic valves.
## PARTNER 3: Incidence of HALT at 30 Days and 1 Year

### TAVR vs SAVR

**Per Protocol Population**

<table>
<thead>
<tr>
<th>Outcomes (%)</th>
<th>30 Days</th>
<th>1 Year</th>
<th>P-value</th>
<th>1 Year</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TAVR (N=165)</td>
<td>Surgery (N=119)</td>
<td>P-value</td>
<td>TAVR (N=153)</td>
<td>Surgery (N=109)</td>
</tr>
<tr>
<td>HALT</td>
<td>13.3</td>
<td>5.0</td>
<td>0.03</td>
<td>27.5</td>
<td>20.2</td>
</tr>
<tr>
<td>1 Leaflet</td>
<td>81.8</td>
<td>66.7</td>
<td></td>
<td>64.3</td>
<td>68.2</td>
</tr>
<tr>
<td>2 Leaflets</td>
<td>9.1</td>
<td>33.3</td>
<td></td>
<td>23.8</td>
<td>31.8</td>
</tr>
<tr>
<td>3 Leaflets</td>
<td>9.1</td>
<td>0</td>
<td></td>
<td>11.9</td>
<td>0</td>
</tr>
</tbody>
</table>

*Event rates are binary and p-value is based on Fisher’s Exact test*

Makkar R, TCT 2019
**PARTNER 3: HALT From 30-Day to 1-Year**

*Per Protocol Population*

<table>
<thead>
<tr>
<th>TAVR</th>
<th>30 Day</th>
<th>1 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HALT</td>
<td>N = 20</td>
<td></td>
</tr>
<tr>
<td>No HALT</td>
<td>N = 119</td>
<td>HALT</td>
</tr>
<tr>
<td>No HALT</td>
<td>N = 92 (77%)</td>
<td>No HALT*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAVR</th>
<th>30 Day</th>
<th>1 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HALT</td>
<td>N = 5</td>
<td></td>
</tr>
<tr>
<td>No HALT</td>
<td>N = 98</td>
<td>HALT</td>
</tr>
<tr>
<td>No HALT</td>
<td>N = 79 (81%)</td>
<td>No HALT*</td>
</tr>
</tbody>
</table>

*Of the 10 TAVR patients and 4 SAVR patients with HALT at 30 days and no HALT at 1 year, none received anticoagulation

Makkar R, TCT 2019
### PARTNER 3: 1-Year HALT and Reduced Leaflet Motion

**Per Protocol Population**

<table>
<thead>
<tr>
<th>HALT Extent</th>
<th>Unrestricted Leaflets</th>
<th>1 Year CT</th>
<th>Partially Restricted</th>
<th>Largely Immobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>188</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&lt;25%</td>
<td>0</td>
<td>29</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>25-50%</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&gt;50-75%</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&gt;75%</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Reduced leaflet motion was noted in 100% of patients with HALT*

*Not all CTs evaluable for HALT were evaluable for leaflet mobility*
PARTNER 3: Mean Aortic Valve Gradient and Severity of HALT at 1 Year

All Patients with Evaluable CTs

<table>
<thead>
<tr>
<th>Severity of HALT</th>
<th>Mean Gradient (mmHg)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HALT &gt; 0%</td>
<td>13.7</td>
<td>0.24</td>
</tr>
<tr>
<td>No HALT</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>HALT &gt; 25%</td>
<td>15.1</td>
<td>0.07</td>
</tr>
<tr>
<td>HALT ≤ 25%</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>HALT &gt; 50%</td>
<td>16.4</td>
<td>0.08</td>
</tr>
<tr>
<td>HALT ≤ 50%</td>
<td>12.6</td>
<td></td>
</tr>
</tbody>
</table>

Makkar R, TCT 2019
PARTNER 3: Death / Stroke / TIA / Thromboembolic Events and 30-Day HALT

TAVR and SAVR

<table>
<thead>
<tr>
<th></th>
<th>HALT</th>
<th>No HALT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>35</td>
<td>311</td>
</tr>
<tr>
<td><strong>n</strong></td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td><strong>p</strong></td>
<td>0.11</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>HALT</th>
<th>No HALT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>35</td>
<td>311</td>
</tr>
<tr>
<td><strong>n</strong></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>p</strong></td>
<td>0.19</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>HALT</th>
<th>No HALT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>35</td>
<td>311</td>
</tr>
<tr>
<td><strong>n</strong></td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td><strong>p</strong></td>
<td>0.27</td>
<td></td>
</tr>
</tbody>
</table>

Makkar R, TCT 2019
Head-to-Head Durability of TAVI vs SAVR
6-Year Outcomes of the NOTION Trial

NOTION: 280 patients at low surgical risk randomized to TAVI or SAVR

**Structural Valve Deterioration**

<table>
<thead>
<tr>
<th></th>
<th>TAVI</th>
<th>SAVR</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve-related deaths</td>
<td>5.0%</td>
<td>3.7%</td>
<td>0.59</td>
</tr>
<tr>
<td>Re-intervention</td>
<td>2.2%</td>
<td>0.7%</td>
<td>0.62</td>
</tr>
<tr>
<td>Severe haemodynamic SVD</td>
<td>0.7%</td>
<td>3.0%</td>
<td>0.21</td>
</tr>
</tbody>
</table>

**Bioprosthetic Valve Failure**

P = 0.89
6.7%
Top 10 Advances in Transcatheter Valve Therapy 2019

1. Edge-to-edge Mitral Valve Repair Trials
2. TAVR Leaflet Durability Studies
3. Antithrombotic Therapy post TAVR
4. Alternate Access for TAVR
5. Tricuspid Valve Intervention
6. Edge-to-edge Mitral Valve Repair Trials
7. TAVR Leaflet Durability Studies
8. Antithrombotic Therapy post TAVR
9. Alternate Access for TAVR
10. Tricuspid Valve Intervention
COAPT Trial
Cardiovascular Outcomes Assessment of the MitraClip Percutaneous Therapy for Heart Failure Patients with Functional Mitral Regurgitation

A parallel-controlled, open-label, multicenter trial in 614 patients with heart failure and moderate-to-severe (3+) or severe (4+) secondary MR who remained symptomatic despite maximally-tolerated GDMT

Randomize 1:1*

MitraClip + GDMT
N=312

GDMT alone
N=302

Follow-up at 30d, 6mo, 1y, 18mo, 2y, 3y, 4y, 5y

*Stratified by cardiomyopathy etiology (ischemic vs. non-ischemic) and site

Mack M, TCT 2019
COAPT Trial: MitraClip Crossovers in GDMT-Assigned Patients

GDMT alone
(N=312)

No MitraClip crossover before 24 months
(N=138)

MitraClip crossover before 24 months
(N=5)*

No MitraClip crossover before 24 months
(N=312)

MitraClip crossover between 24 and 36 mos
(N=53/138; 38.4%)

Total Crossover
(N=58/312; 18.6%)

Not eligible for crossover at 24 months
(N=169)

Death: 124
LVAD: 16
Transplant: 9
Withdrawals: 26
Lost to follow up: 3
Other*: 2

Duration from randomization to crossover:
Median: 25.5 months; Range: 0.2 to 32.9 months
Follow-up after crossover:
Median: 7.7 months; Range: 0.0 to 43.6 months

*Protocol deviation

†No FU data post 24 months
Pt may be in more than one category

Mack M, TCT 2019
COAPT Trial: Primary Effectiveness Endpoint
All Hospitalizations for HF within 36 Months

All patients, ITT, including crossovers

MitraClip + GDMT (n=302)

GDMT alone (n=312)

HR [95% CI] = 0.49 [0.37, 0.63]
p = 0.00000006

NNT = 3.0 [95% CI 2.4, 4.0]

#Joint frailty model

Mack M, TCT 2019
COAPT Trial: Primary Effectiveness Endpoint

All Hospitalizations for HF within 36 Months

All patients, ITT, including crossovers

NNT= 3.0 [95% CI 2.4, 4.0]

GDMT alone
- 378 HFH events per 549.5 pt-yrs
- 68.8%

MitraClip + GDMT
- 220 HFH events per 619.7 pt-yrs
- 35.5%

HR [95% CI]# = 0.49 [0.37, 0.63]
P=0.00000006

#Joint frailty model

Mack M, TCT 2019
COAPT Trial: All-Cause Mortality
All patients, ITT, including crossovers

MitraClip + GDMT (n=302)
GDMT alone (n=312)

HR [95% CI] = 0.67 [0.52, 0.85]
P=0.001
NNT = 7.9 [95% CI 4.6, 26.1]
COAPT Trial: All-Cause Mortality or HF Hospitalization

All patients, ITT, including crossovers

**Mortality or HFH (%)**

- **MitraClip + GDMT (n=302)**: 88.1%
- **GDMT alone (n=312)**: 58.8%

**HR [95% CI] = 0.48 [0.39, 0.59]**

**P=0.0000000000001**

**NNT = 3.4 [95% CI 2.7, 4.6]**

**NNT = 4.5 [95% CI 3.3, 7.0]**
COAPT Trial: Adverse Event Rates
All patients, ITT, 36 months

<table>
<thead>
<tr>
<th>Event</th>
<th>GDMT alone (n=312)</th>
<th>MitraClip + GDMT (n=302)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death or HF Hosp</td>
<td>59.0</td>
<td>88.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Death</td>
<td>42.8</td>
<td>46.5</td>
<td>0.001</td>
</tr>
<tr>
<td>HF hosp</td>
<td>55.5</td>
<td>81.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stroke</td>
<td>7.7</td>
<td>9.8</td>
<td>0.51</td>
</tr>
<tr>
<td>MI</td>
<td>7.7</td>
<td>13.3</td>
<td>0.19</td>
</tr>
<tr>
<td>New CRT implant</td>
<td>3.4</td>
<td>3.1</td>
<td>0.93</td>
</tr>
<tr>
<td>LVAD or Transplant</td>
<td>7.3</td>
<td>11.4</td>
<td>0.03</td>
</tr>
</tbody>
</table>
COAPT Trial: MR Grade at Baseline and 30 Days

Proportion of patients (%)

MitraClip + GDMT (all pts)

Baseline: 51%, 93%
30-day follow-up: 20%, 73%

GDMT only - 58 crossovers censored

Baseline: 45%, 26%
30-day follow-up: 55%, 8%

GDMT only - 58 MitraClip crossover pts

Baseline: 40%, 60%
Within 30 days after crossover: 83%, 96%

MR grade within 30 days after crossover is defined as the MR grade at the scheduled 30-day post MC procedure visit, or MR grade at the latest echo up to 30 days post procedure if the 30-day post MC procedure MR is missing.
Transcatheter Valve Repair for Patients With Mitral Regurgitation

30-Day Results of the CLASP Study

D. Scott Lim, MD, a Saibal Kar, MD, b Konstantinos Spargias, MD, c Robert M. Kipperman, MD, d William W. O’Neill, MD, e Martin K.C. Ng, MBBS, PhD, f Neil P. Fam, MD, g Darren L. Walters, MBBS, MPHIL, h John G. Webb, MD, i Robert L. Smith, MD, j Michael J. Rinaldi, MD, k Azeem Latib, MD, l Gideon N. Cohen, MD, m Ulrich Schäfer, MD, n Leo Marcoff, MD, d Prashanthi Vandrangi, PhD, o Patrick Verta, MD, DVM, MS STAT, o Ted E. Feldman, MD o,p
A. The PASCAL repair system enables Transcatheter valve repair by using individually adjustable clasps to place a spacer between the native valve leaflets.

B. Procedural steps: 1) Introduction of the PASCAL implant into the left atrium; 2) space fills the regurgitant jet area; 3) clasps allow independent leaflet capture and ability to fine-tune leaflet position; 4) successful deployment of the PASCAL implant.

C. PASCAL system allows elongation of the implant, providing a low profile to facilitate maneuvering within subvalvular anatomy.
CLASP Study: Echocardiographic, Functional, and Clinical Results at Baseline and 30 Days at the PASCAL Transcatheter Valve Repair System

Lim et al., J Am Coll Cardiol Intv 2019;12:1369
Transcatheter Valve Repair for Patients With Mitral Regurgitation

30-Day Results of the CLASP Study

CONCLUSIONS The PASCAL repair system showed feasibility and acceptable safety in the treatment of patients with grade 3+ or 4+ MR. MR severity, irrespective of etiology, was significantly reduced and accompanied by clinically and statistically significant improvements in functional status, exercise capacity, and quality of life. (The CLASP Study Edwards PASCAL Transcatheter Mitral Valve Repair System Study; NCT03170349) (J Am Coll Cardiol Intv 2019;12:1369-78)
Top 10 Advances in Transcatheter Valve Therapy 2019

1. 
2. 
3. 
4. 
5. TMVR Trials Update: ViV Sapien, APOLLO, MAC 
6. Edge-to-edge Mitral Valve Repair Trials 
7. TAVR Leaflet Durability Studies 
8. Antithrombotic Therapy post TAVR 
9. Alternate Access for TAVR 
10. Tricuspid Valve Intervention
SAPIEN 3 MViV: 30-day Mortality in Early Experience

**Not Reported**

VIVID
n=349 (18.5% TS)
Dvir et al TVT 2016

TVT
n=586 (49% TS)
Guerrero et al AHA 2017

MITRAL Trial
n=30 (100% TS)
Guerrero et al AHA 2017

- In-Hospital
- 30-Day
All-Cause Mortality According to TMVR

- Valve-in-MAC (n=58)
- Valve-in-Ring (n=141)
- Valve-in-Valve (n=322)

Log-rank p < 0.001

Yoon SH, EHJ 2018;40:441
1-Year Outcomes of Mitral Valve-in-Valve Using the SAPIEN 3 Aortic Transcatheter Heart Valve

Data from the STS/ACC/TVT Registry

Gurrero M et al
TCT 2019
SAPIEN 3 MViV: Procedure Volume Growth and Cases Per Site

Median # of MViV cases per site = 4, IQR [1, 8]
SAPIEN 3 MViV: Trends for Mitral ViV

Guerrero M, TCT 2019
2,144 TMVR procedures using SAPIEN 3 in TVT Registry (June 2015 – Aug 2019)

MVII with S3
n = 1,576

Transseptal
n = 1,326

Transapical
n = 203

MVIR
n = 206

MAC
n = 183

Unknown
n = 179

Transatrial
n = 6

Unspecified
n = 41

*Unknown patient vital status after CMS linkage: 5.3% at 30 days and 17.1% at 1 year.
<table>
<thead>
<tr>
<th></th>
<th>TRANSSEPTAL n=1,326</th>
<th>TRANSAPICAL n=203</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (±SD)</td>
<td>73.4 (±11.86)</td>
<td>72.6 (±11.66)</td>
<td>0.36</td>
</tr>
<tr>
<td>Female (%)</td>
<td>785 (59.2%)</td>
<td>119 (58.6%)</td>
<td>0.88</td>
</tr>
<tr>
<td>NYHA III &amp; IV</td>
<td>1041 (86.5%)</td>
<td>184 (91.1%)</td>
<td>0.07</td>
</tr>
<tr>
<td>Atrial Fibrillation (%)</td>
<td>952 (71.85%)</td>
<td>130 (64%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Prior Stroke (%)</td>
<td>232 (17.5%)</td>
<td>31 (15.3%)</td>
<td>0.45</td>
</tr>
<tr>
<td>COPD (%)</td>
<td>607 (46.2%)</td>
<td>95 (47%)</td>
<td>0.82</td>
</tr>
<tr>
<td>Currently on dialysis (%)</td>
<td>70 (5.3%)</td>
<td>12 (5.9%)</td>
<td>0.71</td>
</tr>
<tr>
<td>Prior CABG (%)</td>
<td>442 (33.4%)</td>
<td>84 (41.4%)</td>
<td>0.03</td>
</tr>
<tr>
<td>Prior AVR (%)</td>
<td>315 (23.8%)</td>
<td>49 (24.1%)</td>
<td>0.91</td>
</tr>
<tr>
<td>Hostile chest (%)</td>
<td>223 (16.8%)</td>
<td>45 (22.2%)</td>
<td>0.06</td>
</tr>
<tr>
<td>STS score (±SD)</td>
<td>11 (±8.58)</td>
<td>11.7 (±9.46)</td>
<td>0.3</td>
</tr>
</tbody>
</table>
SAPIEN 3 MViV: Primary Endpoints

Primary Safety Endpoint: Technical Success

Primary Effectiveness Endpoint: All-Cause Mortality at 1 year

Transseptal: 97.1%
Transapical: 94.6%

Log-Rank $p = 0.0324$
HR: 0.67 [95% CI: 0.47-0.97]

Guerrero M, TCT 2019
SAPIEN 3 MViV: 30-Day and 1-Year Outcomes

30-Day Outcomes

- Death: 5.0% (p=0.07), 1.1% (p=0.91)
- Stroke: 1.0% (p=0.82), 0.4% (p=0.82)
- MV reintervention: 2.0% (p=0.44), 0.5% (p=0.44)
- New pacemaker: 0.2% (p=0.49), 0.5% (p=0.49)
- Device thrombosis: 8.1% (Transseptal), 1.0% (Trasapical)

1-Year Outcomes

- Death: 15.8% (p=0.03), 21.7% (p=0.95)
- Stroke: 3.3% (p=0.78), 3.5% (p=0.78)
- MV reintervention: 0.8% (p=0.44), 0.5% (p=0.44)
- New pacemaker: 2.0% (p=0.17), 2.8% (p=0.17)
- Device thrombosis: 0.3% (p=0.17), 1.2% (p=0.17)

Guerrero M, TCT 2019
### SAPIEN 3 MViV: Predictors of 1-Year All Cause Mortality

<table>
<thead>
<tr>
<th>n(%) or mean (±SD)</th>
<th>UNIVARIATE</th>
<th>MULTIVARIATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR 95% CI</td>
<td>p-value</td>
</tr>
<tr>
<td><strong>Baseline Covariates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transseptal vs Transapical</td>
<td>0.67 [0.47-0.97]</td>
<td>0.033</td>
</tr>
<tr>
<td>Baseline KCCQ Overall Score</td>
<td>0.98 [0.97-0.99]</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Baseline GFR (mL/min/1.73 m²)</td>
<td>0.98 [0.98-0.99]</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Cardiogenic shock within 24 hrs</td>
<td>6.13 [4.18-8.98]</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mod/Sev Tricuspid Insufficiency</td>
<td>1.54 [1.13-2.1]</td>
<td>0.006</td>
</tr>
<tr>
<td><strong>Procedural Covariates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perforation with or without tamponade</td>
<td>21.56 (12.19-38.15)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Conversion to Open Heart Surgery</td>
<td>9.01 [4.61-17.62]</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

**Guerrero M, TCT 2019**
<table>
<thead>
<tr>
<th>Device Name</th>
<th>Description</th>
<th>Primary Outcomes</th>
<th>Status</th>
</tr>
</thead>
</table>
| CardiAQ-EVOQUE (Edwards Lifesciences Inc) | • Nitinol self-expanding trileaflet valve, composed of bovine pericardial tissue  
• Transapical/transseptal  
• EVOQUE valve: new redesigned version of the valve | Compassionate use (n=13): Technical success, 92%; Mortality at 30 d, 45% | • Early Feasibility Study of the CardiAQ TMVI System (Transfemoral and Transapical DS) (NCT02515539); withdrawn  
• A Clinical Study of the CardiAQ TMVI System (Transapical DS) (NCT02478008); early termination  
• RELIEF (CardiAQ-Edwards TMVR Study) (NCT02722551); withdrawn  
• Edwards EVOQUE TMVR Early Feasibility Study (NCT02718001); still recruiting |
| Tiara (NeoVasc Inc, Canada) | • Nitinol self-expanding trileaflet valve of bovine pericardial tissue  
• Transapical | Initial results (n=30): Technical success, 90%; Mortality at 30 d, 10% | • TIARA-I (Early Feasibility Study of the NeoVasc Tiara Mitral Valve System) (NCT02276547); still recruiting  
• TIARA-II (Tiara Transcatheter Mitral Valve Replacement Study) (NCT03039655); still recruiting |
| Tendyne (Abbott Inc) | • Self-expanding trileaflet valve of porcine pericardial tissue, mounted on nitinol double-frame stent  
• Transapical | Initial results (n=100): Technical success, 96%; Mortality at 30 d, 6% | • Expanded Clinical Study of the Tendyne Mitral Valve System—Global Feasibility Study (NCT02321514); still recruiting  
• SUMMIT (Clinical Trial to Evaluate the Safety and Effectiveness of Using the Tendyne Mitral Valve System for the Treatment of Symptomatic Mitral Regurgitation) (NCT03433274); still recruiting  
• Feasibility Study of the Tendyne Mitral Valve System for Use in Subjects With Mitral Annular Calcification (NCT03539458); still recruiting |
| Intrepid (Medtronic Inc) | • Nitinol self-expanding trileaflet valve of bovine pericardial tissue  
• Transapical (transseptal approach under development) | Initial results (n=50): Technical success, 90%; Mortality at 30 d, 14% | • APOLLO (Transcatheter Mitral Valve Replacement With the Medtronic Intrepid TMVR System in Patients With Severe Symptomatic Mitral Regurgitation) (NCT03242642); still recruiting |
| SAPIEN M3 (Edwards Lifesciences Inc) | • Nitinol docking system and a modified SAPIEN 3 valve  
• Transseptal | Initial results (n=15): Technical success, 86.7%; Mortality at 30 d, 0% | • Early feasibility study (NCT03230747); recruitment not known |
| Cardiovalve (Cardiovalve, Israel) | • Dual nitinol frame with a trileaflet bovine pericardium valve  
• Transseptal | Initial results (n=5): Technical success, 100%; Mortality at 30 d, 60% | • AHEAD (Cardiovalve Transfemoral Mitral Valve System) (NCT03813524); still recruiting  
• Cardiovalve Transfemoral System—FIM Study (NCT03958773); still recruiting |
| Cephea (Cephea Valve Technologies) | • Self-expanding double-disk and trileaflet bovine pericardium tissue  
• Transseptal/transapical | Preclinical models  
First-in-human cases recently started | • Cephea Transseptal Mitral Valve System FH (NCT03986946); still recruiting |

*Testa et al., J Am Heart Assoc 2019;8:e013352*
Current TMVR Devices

Abbott (Tendyne); Cardiovalve, Israel (Cardiovalve); Edwards Lifesciences, Inc. (CardiAQ/EVOQUE, FORTIS, SAPIEN M3; HighLife SAS, France (HighLife Bioprosthesis and Subannular Implant); LivaNova, UK (Caisson); Medtronic Inc. (Intrepid); NaviGate Cardiac Structures, Inc, CA (Navigate); Neovasc Inc., Canada (Tiara)

Testa et al., J Am Heart Assoc 2019;8:e013352
APOLLO Trial Expansion
Single Arm MAC Registry

MAC Excluded
- LOCATION / EXPANSION
- MIGRATION
- LVOT OBSTRUCTION
- PVL

Mild-Severe MAC Treated

MAC Registry added to APOLLO

Treating More Patients with Mild-Severe MAC Treated

PILOT

APOLLO

Leon M, TCT 2019
APOLLO MAC Experience

APOLLO Trial Expansion
Single Arm MAC Registry

Careful Additional Anatomic Screening

PATIENTS CONSENTED WITH MAC
276

DISAPPROVED
86

APPROVED
96

MILD
75

MODERATE
18

SEVERE
3

Leon M, TCT 2019
APOLLO Trial Expansion
Edge-to-Edge in the RCT Control Arm

Status Update

• Modifying the study design to include a contemporary control (edge-to-edge repair) as part of the trial
Transfemoral EFS
A Complete “System” Modification

Implant

35 Fr Capsule
Outer Flex

Inner Flex

Delivery System

Indeflator with Flow Reversal System

Loading System

Cradle & Stool (off-the-shelf)

Sheath & Step-up Dilators

Leon M, TCT 2019
Transseptal Transcatheter Mitral Valve Replacement System

A. Transseptal TMVR ensemble
B. Fluoroscopic imaging post-deployment
C. Selected outcomes at 30 days (n=10)
D. MR severity at baseline and 30 days
E. NYHA functional class at baseline and 30 days

Webb et al., J Am Coll Cardiol 2019;73:1239
Clinical Outcomes with TMVR with the Prosthesis

First 100 Patients Treated

- No intra-procedural deaths
- Technical success in 96%
- 30-day death, 6%; 1-year mortality, 26%
- Among survivors at 1 year, 88.5% with mild or no symptoms

Change in Mitral Regurgitation

Sorajja et al., J Am Coll Cardiol 2019;73:1250
Novel Transcatheter Mitral Valve Prosthesis for Patients With Severe Mitral Annular Calcification

CONCLUSIONS Transcatheter mitral valve replacement in severe mitral annular calcification with a dedicated prosthesis is feasible and can result in MR relief with symptom improvement. Further evaluation of this approach for these high-risk patients is warranted. (J Am Coll Cardiol 2019;74:1431-40) © 2019 by the American College of Cardiology Foundation.
Transcatheter Mitral Valve Replacement in Severe Mitral Annular Calcification

Sorajja et al., J Am Coll Cardiol 2019;74:1431
Top 10 Advances in Transcatheter Valve Therapy 2019

1. 
2. 
3. 
4. Procedural Volume and Outcomes after THVs 
5. TMVR Trials Update: ViV Sapien, APOLLO, MAC 
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7. TAVR Leaflet Durability Studies 
8. Antithrombotic Therapy post TAVR 
9. Alternate Access for TAVR 
10. Tricuspid Valve Intervention
Procedural Experience for Transcatheter Aortic Valve Replacement and Relation to Outcomes

The STS/ACC TVT Registry

John D. Carroll, MD, Srekanth Vemulapalli, MD, Dadi Dai, PhD, Roland Matsouaka, PhD, Eugene Blackstone, MD, Fred Edwards, MD, Frederick A. Masoudi, MD, MSPH, Michael Mack, MD, Eric D. Peterson, MD, MPH, David Holmes, MD, John S. Rumsfeld, MD, PhD, E. Murat Tuzcu, MD, Frederick Grover, MD
The Volume-Outcome Association for Outcomes

Mortality

Vascular

Bleeding

Stroke

Carrol et al., J Am Coll Cardiol 2017;70:29
Procedural Volume and Outcomes for Transcatheter Aortic-Valve Replacement

Sreekanth Vemulapalli, M.D., John D. Carroll, M.D.,
Michael J. Mack, M.D., Zhuokai Li, Ph.D., David Dai, Ph.D.,
Andrzej S. Kosinski, Ph.D., Dharam J. Kumbhani, M.D., S.M.,
Carlos E. Ruiz, M.D., Ph.D., Vinod H. Thourani, M.D., George Hanzel, M.D.,
Thomas G. Gleason, M.D., Howard C. Herrmann, M.D.,
Ralph G. Brindis, M.D., M.P.H., and Joseph E. Bavaria, M.D.
Annualized Hospital and Operator Volume of Transfemoral TAVR Procedures

Relationship Between Procedural Volume and Mortality

CONCLUSIONS
An inverse volume–mortality association was observed for transfemoral TAVR procedures from 2015 through 2017. Mortality at 30 days was higher and more variable at hospitals with a low procedural volume than at hospitals with a high procedural volume. (Funded by the American College of Cardiology Foundation National Cardiovascular Data Registry and the Society of Thoracic Surgeons.)
Operator Experience and Procedural Results of Transcatheter Mitral Valve Repair in the United States

Adnan K. Chhatriwalla MD¹, Sreekanth Vemulapalli MD², Molly Szerlip MD³, Susheel Kodali MD⁴, Rebecca T. Hahn MD⁴, John T. Saxon MD¹, Michael J. Mack MD³, Gorav Ailawadi MD⁵, Jennifer Rymer MD², Pratik Manandhar MS², Andrzej S. Kosinski PhD², Paul Sorajja MD⁶
Methods

Mitraclip procedures from the STS/ACC TVT Registry were analyzed categorically according to operator case number

- 1-25, 26-50, and >50 cases

- Operator case number was also analyzed as a continuous variable to allow for visual estimation of the ‘learning curve’

- In the case of two operators with different levels of case experience performing a procedure together, the case was categorized based on the higher case number

Chhatriwalla et al., J Am Coll Cardiol, accepted 2019 Sept 14
Results: Mitraclip Volume

- 14,923 cases performed by 562 operators at 290 sites between 2013 and 2018
- 230 operators with case experience between 26-50
- 116 operators with case experience > 50

Chhatriwalla et al., J Am Coll Cardiol, accepted 2019 Sept 14
## Patient Characteristics (ii)

<table>
<thead>
<tr>
<th></th>
<th>1-25 cases (n=6,431)</th>
<th>26-50 cases (n=3,467)</th>
<th>&gt;50 cases (n=5,025)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR Severity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>moderate-severe or severe (3+/4+)</td>
<td>93.4%</td>
<td>93.3%</td>
<td>92.0%</td>
<td>0.01</td>
</tr>
<tr>
<td>none, trace, mild or moderate (0-2+)</td>
<td>6.1%</td>
<td>6.4%</td>
<td>7.5%</td>
<td></td>
</tr>
<tr>
<td>Mitral Stenosis</td>
<td>5.8%</td>
<td>5.5%</td>
<td>4.2%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Mitral Leaflet Calcification</td>
<td>20.2%</td>
<td>19.8%</td>
<td>20.2%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Mitral Annular Calcification</td>
<td>36.4%</td>
<td>35.4%</td>
<td>36.0%</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>STS PROM-MV Replacement (median, IQR)</td>
<td>8.9 (5.6,13.6)</td>
<td>8.6 (5.5,13.1)</td>
<td>8.5 (5.3,12.9)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>STS PROM-Score-MV Repair (median, IQR)</td>
<td>5.8 (3.5,9.5)</td>
<td>5.7 (3.5,9.0)</td>
<td>5.4 (3.3,8.9)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Functional MR</td>
<td>15.2%</td>
<td>18.7%</td>
<td>23.7%</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Chhatriwalla et al., J Am Coll Cardiol, accepted 2019 Sept 14
Unadjusted Outcomes: Procedural Success

Chhatriwala et al., J Am Coll Cardiol, accepted 2019 Sept 14
Unadjusted Outcomes: Procedure Time

Chhatriwalla et al., J Am Coll Cardiol, accepted 2019 Sept 14
Procedural Complications

Composite of Complications
- In-hospital death
- Cardiac perforation
- Stroke
- Bleeding at access site
- Blood transfusion

Cases 1-25 (n=6,429)
Cases 26-50 (n=3,466)
Cases 50+ (n=5,025)

Chhatriwalla et al., J Am Coll Cardiol, accepted 2019 Sept 14
Procedural Success: Learning Curve Analysis*

Acceptable (≤ 2+ residual MR)

Optimal (≤ 1+ residual MR)

*Curves generated using hierarchical generalized linear mixed models

Chhatriwalla et al., J Am Coll Cardiol, accepted 2019 Sept 14
Procedure Time and Procedural Complications*

* Curves generated using hierarchical generalized linear mixed models

Chhatriwalla et al., J Am Coll Cardiol, accepted 2019 Sept 14
Conclusions

- A procedural learning curve does exist for transcatheter mitral valve repair with MitraClip and these findings are independent of mechanism of MR.

- These findings have important implications as to the level of training and experience necessary to achieve optimal outcomes in this challenging patient population.
Top 10 Advances in Transcatheter Valve Therapy 2019

1. 
2. 
3. TAVR vs SAVR in Intermediate Risk AS: 5-Yr Results
4. Procedural Volume and Outcomes after THVs
5. TMVR Trials Update: ViV Sapien, APOLLO, TENDYNE
6. Edge-to-edge Mitral Valve Repair Trials
7. TAVR Leaflet Durability Studies
8. Antithrombotic Therapy post TAVR
9. Alternate Access for TAVR
10. Tricuspid Valve Intervention
Five-year Outcomes from the PARTNER 2A Trial: Transcatheter vs. Surgical Aortic Valve Replacement in Intermediate-Risk Patients
PARTNER 2A 5-Yr: Primary Endpoint (Death and Stroke)

ITT Population

Death or Stroke (%)

0 12 24 36 48 60

TAVR (n=1,011)

SAVR (n=1,021)

HR: 1.09 [95% CI: 0.95, 1.25]
P = 0.21

Thourani VK, TCT 2019
PARTNER 2A 5-Yr: Primary Endpoint 2-Yr Landmark Analysis

ITT Population

- TAVR (n=1,011)
- SAVR (n=1,021)

Death or Stroke (%)

- HR: 0.89 [95% CI: 0.73, 1.09]
- HR: 1.27 [95% CI: 1.06, 1.53]

Thourani VK, TCT 2019
PARTNER 2A 5-Yr: Aortic Valve Area

VI Population

<table>
<thead>
<tr>
<th>No. of Echos</th>
<th>Baseline</th>
<th>30 Days</th>
<th>1 Year</th>
<th>2 Years</th>
<th>3 Years</th>
<th>4 Years</th>
<th>5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAVR</td>
<td>899</td>
<td>827</td>
<td>695</td>
<td>572</td>
<td>468</td>
<td>365</td>
<td>289</td>
</tr>
<tr>
<td>Surgery</td>
<td>861</td>
<td>726</td>
<td>590</td>
<td>490</td>
<td>413</td>
<td>349</td>
<td>259</td>
</tr>
</tbody>
</table>

Aortic Valve Area (cm$^2$)

- Baseline: TAVR 0.70, Surgery 0.69
- 30 Days: TAVR 1.67, Surgery 1.47
- 1 Year: TAVR 1.57, Surgery 1.42
- 2 Years: TAVR 1.54, Surgery 1.40
- 3 Years: TAVR 1.54, Surgery 1.39
- 4 Years: TAVR 1.48, Surgery 1.36
- 5 Years: TAVR 1.5, Surgery 1.37

P = 0.001

Thourani VK, TCT 2019
PARTNER 2A 5-YEAR Results

Primary endpoint
- TAVR: 47.9%
- SAVR: 43.4%
- \( p=0.21 \)

Transfemoral subset
- TAVR: 44.5%
- SAVR: 42%
- \( p=0.80 \)

mod - severe PVL 6.5
- TAVR: 0.4%
- SAVR: 4.4%
- \( p<0.05 \)
PARTNER 2A 5-Yr: Paravalvular Regurgitation

VI Population

<table>
<thead>
<tr>
<th></th>
<th>30 Days</th>
<th>2 Years</th>
<th>5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAVR</td>
<td>73.7%</td>
<td>64.9%</td>
<td>66.8%</td>
</tr>
<tr>
<td>Surgery</td>
<td>96.7%</td>
<td>95.9%</td>
<td>93.8%</td>
</tr>
<tr>
<td>Patients (%) Mod/Severe</td>
<td>3.8%</td>
<td>8.2%</td>
<td>6.5%</td>
</tr>
<tr>
<td></td>
<td>2.8%</td>
<td>3.5%</td>
<td>5.9%</td>
</tr>
</tbody>
</table>

No. of Echos:

- TAVR: 872
- Surgery: 757
- TAVR: 609
- Surgery: 516
- TAVR: 310
- Surgery: 272

Thourani VK, TCT 2019
PARTNER 2A 5-Yr: Death from Any Cause by PVR Severity
VI TAVR Population

Overall Log-Rank P < 0.001

Mild vs mod-severe P = 0.007
Mild vs none-trace P = 0.07

No. at risk:

<table>
<thead>
<tr>
<th>Severity</th>
<th>Sapien XT</th>
<th>SAPIEN 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>None-trace</td>
<td>643</td>
<td>277</td>
</tr>
<tr>
<td>Mild</td>
<td>196</td>
<td>225</td>
</tr>
<tr>
<td>Mod-severe</td>
<td>33</td>
<td>63</td>
</tr>
</tbody>
</table>

Thourani VK, TCT 2019
Outcomes of Transcatheter Aortic Valve Replacement with Balloon-Expandable Sapien3 Valve in Bicuspid Aortic Stenosis: An analysis of the STS/ACC TVT Registry
Study Population

92236 SAPIEN 3 Cases in TVT Registry
(June 2015 – Nov 2018)
552 Sites

3196 Valve-in-Valve
136 Prior TAVR

7082 N/A, Uncertain,
Unicuspid, Quadricuspid

2726 Bicuspid AS
SAPIEN 3 Patients

79096 Tricuspid AS
SAPIEN 3 Patients

1:1 Propensity Matching

2691 Bicuspid AS
SAPIEN 3 Patients

2691 Tricuspid AS
SAPIEN 3 Patients

25 Covariates used for propensity matching

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Chronic Lung Disease</td>
</tr>
<tr>
<td>Gender (male)</td>
<td>Prior PCI</td>
</tr>
<tr>
<td>NYHA III/IV</td>
<td>Prior CABG</td>
</tr>
<tr>
<td>BMI</td>
<td>Porcelain Aorta</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Mean Gradient</td>
</tr>
<tr>
<td>Diabetes</td>
<td>LVEF</td>
</tr>
<tr>
<td>Creatinine ≥ 2</td>
<td>Mitral Regurgitation</td>
</tr>
<tr>
<td>Peripheral Arterial</td>
<td>Tricuspid Regurgitation</td>
</tr>
<tr>
<td>Disease</td>
<td></td>
</tr>
<tr>
<td>Carotid Stenosis</td>
<td>5 Meter Walk Test</td>
</tr>
<tr>
<td>Atrial Fibrillation</td>
<td>Access Site</td>
</tr>
<tr>
<td>Prior Stroke</td>
<td>KCCQ</td>
</tr>
<tr>
<td>Immunocompromised</td>
<td>Hemoglobin</td>
</tr>
<tr>
<td>GFR</td>
<td></td>
</tr>
</tbody>
</table>

Makkar R, ACC 2019
## Procedural Outcomes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Bicuspid AS (n=2691)</th>
<th>Tricuspid AS (n=2691)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device success</td>
<td>96.5</td>
<td>96.6</td>
<td>0.87</td>
</tr>
<tr>
<td>Procedure Time, min</td>
<td>100.7 ± 51.8</td>
<td>98.2 ± 52.1</td>
<td>0.08</td>
</tr>
<tr>
<td>Fluoroscopy Time, min</td>
<td>18.5 ± 11</td>
<td>17.1 ± 10.2</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Conversion to open surgery</td>
<td>0.9</td>
<td>0.4</td>
<td>0.03</td>
</tr>
<tr>
<td>Annulus Rupture</td>
<td>0.3</td>
<td>0.0</td>
<td>0.02</td>
</tr>
<tr>
<td>Cardiopulmonary bypass</td>
<td>1.4</td>
<td>1.0</td>
<td>0.13</td>
</tr>
<tr>
<td>Aortic dissection</td>
<td>0.3</td>
<td>0.1</td>
<td>0.34</td>
</tr>
<tr>
<td>Coronary Obstruction</td>
<td>0.4</td>
<td>0.3</td>
<td>0.34</td>
</tr>
<tr>
<td>Need for a second valve</td>
<td>0.4</td>
<td>0.2</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Makkar R, ACC 2019
1-Year Results

1-Year Mortality - Matched

1-Year Stroke - Matched

Makkar R, ACC 2019
1. Early TAVR/SAVR or Observation for Asymptomatic AS
2. TAVR vs SAVR in Intermediate Risk AS: 5-Yr Results
3. Procedural Volume and Outcomes after THVs
4. TMVR Trials Update: ViV Sapien, APOLOLO, TENDYNE
5. Edge-to-edge Mitral Valve Repair Trials
6. TAVR Leaflet Durability Studies
7. Antithrombotic Therapy post TAVR
8. Alternate Access for TAVR
9. Tricuspid Valve Intervention
Emerging Indications of TAVR

Pt with moderate to severe AS

ViV Bioprosthetic Degeneration

Bicuspid AS

Watch TAVR

TAVR in pure AI

LFLG AS

Early TAVR in asymptomatic severe AS

Moderate AS with CHF
EARLY TAVR Trial: 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% per 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>SURTAVI Intermediate Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoreValve TAVR</td>
<td>SAVR</td>
</tr>
<tr>
<td>2.2% (Latest 0%)</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>30-Day Mortality</th>
<th>PARTNER Trial 2A Intermediate PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sapien 3 TAVR</td>
<td>SAVR</td>
</tr>
<tr>
<td>1.1%</td>
<td>4.0%</td>
</tr>
</tbody>
</table>

Genereux et al., J Am Coll Cardiol 2016;67:2263; Reardon et al., N Engl J Med 2017;376:1321; Thourani et al., Lancet 2016;387:2218
Asymptomatic, Severe Aortic Stenosis

Screening/Stress Test
Inclusion/exclusion criteria, treadmill stress test

Asymptomatic
Negative stress test OR medical history

1:1 Randomization

Transfemoral TAVR
Clinical Surveillance

Primary Endpoint
2 yr composite of all-cause mortality, all stroke, and unplanned cardiovascular hospitalization

Symptomatic
Positive stress test

Registry
Commercial AVR (TAVR or SAVR), Clinical Trial (e.g. PARTNER 3 Trial), etc.

PI: Philippe Généreux, MD
Chair: Martin B. Leon, MD
NCT03042104
Early Surgery or Conservative Care for Asymptomatic Aortic Stenosis

Duk-Hyun Kang, M.D., Ph.D., Sung-Ji Park, M.D., Ph.D.,
Seung-Ah Lee, M.D., Sahmin Lee, M.D., Ph.D.,
Dae-Hee Kim, M.D., Ph.D., Hyung-Kwan Kim, M.D., Ph.D.,
Sung-Cheol Yun, Ph.D., Geu-Ru Hong, M.D., Ph.D.,
Jong-Min Song, M.D., Ph.D., Cheol-Hyun Chung, M.D., Ph.D.,
Jae-Kwan Song, M.D., Ph.D., Jae-Won Lee, M.D., Ph.D.,
and Seung-Woo Park, M.D., Ph.D.
RECOVERY: Enrollment, Randomization, and Follow-Up

RECOVERY: Primary Composite Endpoint and Death from Any Cause

# RECOVERY: Primary and Secondary Endpoints

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Conservative Care (N=72)</th>
<th>Early Surgery (N=73)</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary end point:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operative mortality or death from cardiovascular causes during follow-up†</td>
<td>11 (15)</td>
<td>1 (1)</td>
<td>0.09 (0.01–0.67)</td>
</tr>
<tr>
<td><strong>Secondary end points</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death from any cause</td>
<td>15 (21)</td>
<td>5 (7)</td>
<td>0.33 (0.12–0.90)</td>
</tr>
<tr>
<td>Clinical thromboembolic event</td>
<td>4 (6)</td>
<td>1 (1)</td>
<td>0.30 (0.04–2.31)</td>
</tr>
<tr>
<td>Stroke</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Repeat aortic-valve surgery</td>
<td>2 (3)</td>
<td>0</td>
<td>0.19 (0.10–8.00)</td>
</tr>
<tr>
<td>Hospitalization for heart failure</td>
<td>8 (11)</td>
<td>0</td>
<td>0.05 (0.00–1.05)</td>
</tr>
</tbody>
</table>

RECOVER: Early Surgery or Conservative Care in Asymptomatic Severe AS (6.2 Yrs F/U)

Operative CV Mortality

- Early Surgery (n=73)
- Conservative Care (n=72)

AVR at 4 yrs = 62%; 8 yrs = 92%

Early Surgery or Conservative Care for Asymptomatic Aortic Stenosis

CONCLUSIONS
Among asymptomatic patients with very severe aortic stenosis, the incidence of the composite of operative mortality or death from cardiovascular causes during the follow-up period was significantly lower among those who underwent early aortic-valve replacement surgery than among those who received conservative care. (Funded by the Korean Institute of Medicine; RECOVERY ClinicalTrials.gov number, NCT01161732.)
Top 10 Advances in Transcatheter Valve Therapy 2019

1. TAVR vs SAVR in Low Surgical Risk AS
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9. Alternate Access for TAVR
10. Tricuspid Valve Valve Intervention
TAVR Risk Assessment
Risk Stratification Redefined

Traditional

Low <3%
Intermediate <4-8%
High 8-15%
Extreme/Inoperable 15%+

Recent/Contemporary

Lower risk <3%
Higher risk >3%
TAVR for Low Risk Symptomatic AS patients

STS mortality risk of <3%

One Trial OUS: Notion Trial (Completed) - CoreValve
One Registry in US: 200pts, 1M data

Two Trials in US have completed:
PARTNER-3 of Sapien-3 vs SAVR (n=1228)
Evolut-R CoreValve vs SAVR (n=1200) Trials

One OUS Trial: Notion-2 (n=1000) - ongoing
NOTION: Death (All-Cause), Stroke or MI at 5-Years (As-Treated)

CoreValve vs Surgery in Low-Risk Patients (n=280)

Thyregod, ACC 2018
NOTION Trial: Clinical Outcomes at 5 Years

280 patients with severe AS at low surgical risk for SAVR or TAVR with self-expanding CoreValve

- Primary Endpoint: Death, Stroke, MI, PPM Implantation, Valve Endocarditis
- TAVR (n=145) vs SAVR (n=135)

<table>
<thead>
<tr>
<th>Endpoint</th>
<th>TAVR (%)</th>
<th>SAVR (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Endpoint</td>
<td>29.1</td>
<td>30.2</td>
<td>0.47</td>
</tr>
<tr>
<td>Death</td>
<td>20.0</td>
<td>23.0</td>
<td>0.56</td>
</tr>
<tr>
<td>Stroke</td>
<td>6.8</td>
<td>7.3</td>
<td>0.85</td>
</tr>
<tr>
<td>MI</td>
<td>7.7</td>
<td>7.8</td>
<td>0.87</td>
</tr>
<tr>
<td>PPM Implantation</td>
<td>43.7</td>
<td>9.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Valve Endocarditis</td>
<td>9.0</td>
<td>4.3</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Sondergaard et al. TCT 2018
PARTNER 3 Background

PARTNER 3
• RCT 1:1
• vs. Surgery
• N = 1000 pts

Low Risk

Leon MB, ACC 2019
PARTNER 3 Study Design

Symptomatic Severe Aortic Stenosis

Low Risk/TF ASSESSMENT by Heart Team (STS < 4%)

1:1 Randomization
1000 Patients

TAVR (SAPIEN 3 THV)
Surgery (Surgical Bioprosthetic Valve)

Follow-up: 30 day, 6 mos, and annually through 10 years

PRIMARY ENDPOINT:
Composite of all-cause mortality, stroke, or CV re-hospitalization at 1 year post-procedure

Leon MB, ACC 2019
PARTNER 3: Primary Endpoint

- Surgery: Upper 95% CI of risk diff = -2.5%
- TAVR: $P_{\text{non-inferiority}} < 0.001$
- $P_{\text{superiority}} = 0.001$

Graph showing:
- Death, Stroke, or Rehospital (%) over months after procedure:
  - Surgery: 15.1% at 12 months
  - TAVR: 8.5% at 12 months

Number at risk:
- Surgery: 454, 408, 390, 381, 377, 374
- TAVR: 496, 475, 467, 462, 456, 451

Leon MB, ACC 2019
PARTNER 3: Clinical Outcomes at 1 Year

Medtronic TAVR in Low Risk Patients

Trial Design & leaflet Sub-study

- **Patient Population: Low Risk Cohort**
  - Determined by Heart Team to be low surgical risk

- **Primary Endpoint:**
  - **Safety:** Death, all stroke, life-threatening bleed, major vascular complications or AKI at 30 days
  - **Efficacy:** Death or major stroke at 2 yrs

- **Sample Size:** ~1200 Subjects

- **Follow-up Evaluations:**
  - 30-days, 6-month, 18-month, and 1 through for 5 years

- **Number of Sites:** Up to 80 sites
Primary Endpoint: All cause mortality and disabling stroke at 2 yrs

Reardon MJ, ACC 2019
## Evolut Low-Risk Trial: Clinical Outcomes at 1 Year

**Table:**

<table>
<thead>
<tr>
<th>Event</th>
<th>TAVR (N=725)</th>
<th>SAVR (N=678)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS, days</td>
<td>2.6</td>
<td>6.2</td>
</tr>
<tr>
<td>Aortic Valve Area, cm²</td>
<td>2.3</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Graph:**

- **Death or Stroke:** TAVR 2.9%, SAVR 4.6%
- **Death:** TAVR 2.4%, SAVR 3%
- **Stroke:** TAVR 4.1%, SAVR 4.3%
- **Disabling stroke:** TAVR 0.8%, SAVR 2.4%
- **HF hosp:** TAVR 3.2, SAVR 6.5
- **Vascular compl:** TAVR 3.8, SAVR 3.5
- **A-fib:** TAVR 9.8, SAVR 19.4
- **PPM:** TAVR 6.7, SAVR 6.7

*Popma et al., N Engl J Med 2019;380:1706*
Transcatheter Aortic-Valve Replacement with a Self-Expanding Valve in Low-Risk Patients

Jeffrey J. Popma, M.D., G. Michael Deeb, M.D., Steven J. Yakubov, M.D., Mubashir Mumtaz, M.D., Hemal Gada, M.D., Daniel O'Hair, M.D., Tanvir Bajwa, M.D., John C. Heiser, M.D., William Merhi, D.O., Neal S. Kleiman, M.D., Judah Askew, M.D., Paul Sorajja, M.D., Joshua Rovin, M.D., Stanley J. Chetcuti, M.D., David H. Adams, M.D., Paul S. Teirstein, M.D., George L. Zorn III, M.D., John K. Forrest, M.D., Didier Tchêchê, M.D., Jon Resar, M.D., Antony Walton, M.D., Nicolo Piazza, M.D., Ph.D., Basel Ramlawi, M.D., Newell Robinson, M.D., George Petrossian, M.D., Thomas G. Gleason, M.D., Jae K. Oh, M.D., Michael J. Boulware, Ph.D., Hongyan Qiao, Ph.D., Andrew S. Mugglin, Ph.D., and Michael J. Reardon, M.D., for the Evolut Low Risk Trial Investigators*

CONCLUSIONS

In patients with severe aortic stenosis who were at low surgical risk, TAVR with a self-expanding supraannular bioprosthesis was noninferior to surgery with respect to the composite end point of death or disabling stroke at 24 months. (Funded by Medtronic; ClinicalTrials.gov number, NCT02701283.)

This article was published on March 16, 2019, at NEJM.org.

DOI: 10.1056/NEJMoa1816885
Copyright © 2019 Massachusetts Medical Society.
FDA Expands TAVR Indication to Low-Risk Patients

Both Evolut R and Evolut PRO, as well Sapien 3, received the expanded indication in today’s eagerly awaited announcement.

(UPDATED) The US Food and Drug Administration has approved an expanded indication for the self-expanded Evolut series (Medtronic) and the balloon-expandable Sapien 3 and Sapien Ultra (Edwards Lifesciences) transcatheter heart valves for the treatment of patients with severe aortic stenosis at low risk for surgery.

The valves are now approved across the entire spectrum of risk, including patients ineligible for surgery, those at high or intermediate risk, and— as of today— those at low risk.
Tens of Thousands of Heart Patients May Not Need Open-Heart Surgery

Replacement of the aortic valve with a minimally invasive procedure called TAVR proved effective in younger, healthier patients.

By Gina Kolata

March 16, 2019

FDA Approved TAVR for Low risk AS August 2019
TAVR Guidelines

The “New” AHA/ACC Focused Update

2017 AHA/ACC Focused Update of the 2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease

A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines

Severe AS
Symptomatic

Surgical Risk Strata

Low
SAVR
IB

Intermediate
SAVR or TAVR
IA

High
SAVR or TAVR
IA

Prohibitive
TAVR
IA
J wire can help reaching at the valve inflow area.

Low coronary height in combination with high implantation of balloon expandable valve can lead to valve struts facing the coronaries and poses challenge during catheter engagement.
Top 10 Advances in Transcatheter Valve Therapy 2019

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10. Tricuspid Valve Valve Intervention
Annual TAVR Procedures in USA: TVT Registry 2012 to 2018

Procedural Performance and Outcome of TAVR since FDA Approval

- **Observed Mortality:**
  - 2012: 5.54%
  - 2013: 5.21%
  - 2014: 4.38%
  - 2015: 4.12%
  - 2016: 3.81%
  - 2017: 3.12%
  - 2018: 2.91%

- **2019:** ≈5000 TAVR per month in USA

- **Projected:** 60,000

- **N:**
  - 2012: 4,590
  - 2013: 13,629
  - 2014: 26,414
  - 2015: 30,012
  - 2016: 40,216
  - 2017: 48,172
  - 2018: Projected 60,000
TAVR Procedures at MSH: 2015 to 2019 (YTD)

Major complication: N = 12, 10, 8, 10, 14

Length of Stay in Days:
- 2015: 6.3
- 2016: 4.9
- 2017: 4.7
- 2018: 4.1
- 2019 YTD: 2.9

O/E Mortality Ratio:
- 2015: 1.64
- 2016: 0.69
- 2017: 0.85
- 2018: 0.75
- 2019 YTD: 1.0
MSH TAVR Outcomes 2018

N=290 (49% Evolut-R CoreValve, 51% SAPIEN-3)

75% Conscious Sedation; 25% GA

88% Perc Femoral; 10% Cutdown Femoral; 1.4% Subclavian; 0.6% Direct Aortic
MitraClip/TriClip Procedures at MSH: 2015 to 2019 YTD

In-Hospital Death: $N = 2$

<table>
<thead>
<tr>
<th>Year</th>
<th>MitraClip</th>
<th>TriClip</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>51</td>
<td>1 TriClip</td>
</tr>
<tr>
<td>2018</td>
<td>50</td>
<td>4 TriClip</td>
</tr>
<tr>
<td>2019 YTD</td>
<td>75</td>
<td>3 TriClip</td>
</tr>
</tbody>
</table>

In Hospital Death: $N = 2$
Top 10 Advances in Transcatheter Valve Therapy 2019

**Reasons for selection of the articles**

Revolutionary / significant observation

Widespread acceptance

Change in clinical practice

- TMVR for MAC, AC for TAVR, 5Y Int risk TAVR
- TMVR, TTVR, TAVR in BAV, TAVR durability:
- ViV TMVR, Carotid TAVR, MVRepair, THV volume:
- TAVR Low risk, SAVR in Asymptomatic AS:

Final result → BETTER INTERVENTION & PT’s SURVIVAL
Watch our monthly live webcasts from our new and improved website!

COMPLEX CORONARY CASES
Occurs 3rd Tuesday of the month at 8am

LIVE PERIPHERAL INTERVENTIONS
Every 4th Wednesday at 8am

STRUCTURAL HEART LIVE CASES
Every other Tuesday at 9am

www.ccclivecases.org
Structural Heart Webcast Series
www.structuralheartlivecases.org

2nd Tuesday of the Other Month 9-10am:
Next webcast
January 14, 2020

This is a great addition to our monthly;
- CCClivecases.org for 10+ yrs
- Peripheralinterventions.org for 6+ yrs.
Total www.ccclivecases.org Pageviews = 619,057